FEBRUARY, 1902. No. 1.

THE JOURNAL

OF THE

American Foundrymen's Association.

Published Monthly by the Association at 95 Griswold Street,
DETROIT, MICHIGAN.

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Address: [illegible] Single Copies 10 Cents.

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VOL. 4. JANUARY, 1898. NO. 19.

The American Foundrymen's Association is not responsible for any statement or opinion that may be advanced by any contributor to this Journal.

PROCEEDINGS OF THE PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

At the last meeting of this Association held in Philadelphia, December 1st, the executive committee reported as follows:

"This meeting finds us in the last month of the year, when we had expected every foundry in the land would have all it could do running six days per week. As a matter of fact, we find there is a great improvement over this time last year, and while there is room for further improvement, the output of the foundries in general is very much better than it has been at any time during this year. This, of course, is more satisfactory; but the trouble is still that prices are exceedingly low, and we do not see that this condition of affairs can be bettered until the foundries are all filled up with work, when they can afford to ask better prices for new contracts. In other words, supply and demand have much to do with business in general. It looks as though the supply was greater than the demand; but this great and prosperous country is growing very fast, and it seems that the near future will bring with it a better demand and at better prices. We know of a large number of foundries that have about all they can do, some of them having enough work to run their shops full for six months, while others are doing a hand-to-mouth business that is not at all satisfactory. But as a rule we can see a great improvement over

the past year. To-night we have no set paper, and the attention of the meeting is called to discussion on topics of interest to foundrymen leading up to economical productions. We think the thought expressed by our president at the last meeting, inviting the proprietors of the different foundries to bring with them their superintendents and foremen to the meetings is a good one, and will enable those acting upon it to pick up information of value to the plants which they represent."

A general discussion followed in which trade conditions were reported as being more encouraging than for some time, although the prices obtained for castings were showing no tendency to advance.

PROCEEDINGS OF THE WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Western Foundrymen's Association was held Wednesday evening, December 15, 1897, at the Great Northern Hotel, Chicago.

In the absence of the president, Wm. Ferguson, vice-president, occupied the chair.

W. N. Moore read the paper of the evening, entitled:

METHOD FOR KEEPING WEEKLY SHOP COSTS.

The necessities of shop management with reference to current cost records are: that they be practically accurate, continuously formed as a running record, always up to date within the shortest possible interval, and that the method be direct and inexpensive. The plan here given for recording labor and material costs has been in use for some years in a stove foundry, and has met these requirements. The various operations of the shop are classified, grouped, and, so far as desired, designated by separate numbers which are known as "shop numbers," and are also used to designate corresponding ledger accounts.

As a matter of convenience, certain numbers are reserved for what are known as standing shop orders, which relate to constant operations; such as Cupola Attendance, Unloading Material, Care of Boiler and Engine, Repairs to Building, Repairs to Flasks and Machinery, Warehouse Labor, etc. Other numbers are reserved for Molding, Mounting, Nickeling, etc. Numbers between 1 and 10 indicate General Labor items. Those between 20 and 30, Machinery and Power; 300 to 400 indicate Mounting Shop Operations; 400 and above are used for special jobs, done either on shop account or custom work. These reservations add a significance to the numbers themselves and facilitate their proper use.

The day worker is furnished with a card such as shown in Fig. 1. On it he records daily the number of hours employed,

and makes his own distribution of the time against the single, or several shop orders under which he has been employed during the day. These cards are taken out in the morning and returned at night. He also registers on a Bundy time clock. At the end of the week the time reported is checked by the time clock record. The cards are computed vertically and horizontally, so that a workman's distribution of time must be complete, and is checked by the time paid for.

FIG. 1.

John Smith. No.....

Week ending 6-20-97

S. O.	M.	T.	W.	T.	F.	S.	Hrs.	Rate	Am't.
372	9						9	2.25	2 02
37		8	9		9		26		5 85
63		1					1		22
342						9	9		2 03
Total,	9	9	9		9	9	45		10 12
A. M.									
P. M.									

For piece work, a similar form is used, shown in Fig. 2. The workman is provided with a duplicate card for his convenience, but the real record is made by the timekeeper and foreman, using the ordinary means of a gangway count and discount pile. This is cumbersome, but no better way has been found.

At the end of the week, the computations having been made, the cards collectively form a complete pay-roll. But, for the

sake of convenience, the items are carried forward and concentrated in a pay-roll book in which are recorded the names of the workmen with the amounts due; and, under a separate tabulation, the various items shown on the card distribution are brought together under their common shop order numbers. The two sides of the pay-roll—the wages paid and the distribution—being in balance, the pay-roll forms an accurate source from which ledger charges against the shop orders are made. These shop order accounts are carried in the ledger, where they can be referred to when desired, and, at the end of the year, enter into an annual cost sheet with which we will not deal in this paper, but

FIG. 2.

Name *John Smith.* Week ending 6-20-97

S. O. No.	Stove.	Board No.	M.	T.	W.	T.	F.	S.	Total.		Price.	Amount.	Net.
86	M. H. 3 B	7	23 / 1	23 / 3	23 / 2	19	24 / 1		112 / 7	105	18	18 90	
84	Job work					1			1		25	25	
	86—18 90												19 15
	84— 25												
	19 15												

only with running records which are made and exposed as often as the pay-roll is made up.

For the purpose of making ready comparison, the weekly expenditures appearing in the pay-roll under the various shop orders are then grouped under these headings: Superintendence, including watchman, power, etc.; General Labor, including yards, cupola, cleaning, grinding, etc.; Warehouse; Molding; Mounting; Nickeling; Repairs, and Improvements. The castings made are of such uniform character as regards expenditures under the first three of these groups that such differences as exist are ignored. There are occasional exceptions where an undue proportion of gate, extra hazard from loss or breakage, or other

conditions, require recognition, to fix individual costs. But for the purpose of this record, these expenditures are charged uniformly against the product by weight, the basis of the charge being 100 lbs. net production of finished castings, deductions being made for all returns to the cupola from whatever cause. The accuracy as to net product is insured by having all returned castings weighed back over the out scales and reported on the daily weight sheet. Liability to error is also decreased by having its weight plainly marked on each truck or barrow, and having the gross and tare both recorded.

A computation on the same basis is also made of the cost of molding; but as this is all done by piece work, and the cost per cwt. naturally varies greatly according to the character of the work in the shop, the figures are only of general interest.

In the other departments—mounting and plating shops—where day-work prevails, the natural cost of the various productions bear so little relation to their weights that comparisons on this basis would be valueless. Therefore, in ascertaining results being obtained in these departments, there is first placed an arbitrary cost price, determined from previous experience, on each stove or piece produced. The weekly outputs of these departments are computed at these assumed costs, and the difference between this computation and the actual pay-roll expenditure is shown as a percentage. This percentage of difference, either above or below the assumed cost of the weekly output, forms a very satisfactory gauge, both for making comparisons and ascertaining exact costs.

Those items in the pay-roll which are grouped under repairs and improvements are not made a matter of weekly comparison, as expenditures in these directions are considered as arising more from general policy than from current shop management. They occupy a proper place in the yearly cost sheet.

Of the purchased material which enters into the production of castings, a comparative record of weekly consumption is kept of iron, coke and steam coal only. Iron and coke are weighed as they come up to the charging floor, and the daily weight sheet

shows both the gross and tare of each load. Coal is similarly weighed to the boiler room. The materials so delivered are considered as consumed, although the actual daily consumption may only approximately tally. For obtaining an accurate record, this is found to be more reliable than a system by which the weighing is concurrent with the operation of charging, there being at most only a slight temporary inaccuracy in the weekly totals, due to the variation in the amount of surplus stocks which may remain on the charging floors at the weeks' ends. The weekly report shows the number of pounds of each of these several materials which have been used to produce 100 lbs. of finished product. It also shows the total number of pounds melted, the returns of broken and discarded castings, and the discount—each computed on the same basis.

The full report is as follows, the figures being entirely fictitious:

WEEK ENDING JANUARY 1, 1898.

Net product	125,000	lbs.
Iron, per cwt. of product	94.4	lbs.
Coke, per cwt. of product	20.3	lbs.
Coal, per cwt. of product	5.7	lbs.
Total melt, per cwt. of product	157.	lbs.
Breakage and obsolete, per cwt. of product	3.	lbs.
Discount of product	4.5	lbs.

Group I.—Molding	$ .97	
Group II.—Superintendence, etc	.124	
Group III.—General labor	.325	
Group IX.—Warehouse	.156	
Group V.—Mounting department	Gain, $32.50	9.7%
Group X.—Plating department	Loss, 17.00	4.6%

These reports are gotten out by Thursday, covering the operations of the preceding week. The remedial value of information of this character comes not only from knowing it, but from knowing it quickly.

The cost of clerical work involved in keeping this record, over and above that required for the simplest form of pay-roll accounting, is not such as to affect its usefulness. The method has a natural fluency, one step following another in simple routine, and but little, or no knowledge of the operations of the shop is required to carry correctly the original entries through to the conclusions.

DISCUSSION.

Mr. Ferguson: I would like to inquire how long it took from the commencement of this system before you obtained satisfactory results.

Mr. Moore: It has been in use for six or eight years; and it was begun so long ago that I can hardly answer the question. It proved satisfactory from its inception.

Mr. Ferguson: We are just now beginning with a system, but I am afraid it is going to take too long before we can get at satisfactory results.

Mr. Thompson: While Mr. Moore says the figures given in the paper are entirely fictitious, I would like to ask him if 94.4 per cwt. is anything like the general average of casting produced from 100 pounds of melted iron.

Mr. Moore: I would answer that question by stating that the figures are entirely fictitious. They are not intended to convey anything as to actual results. At the same time if it had been 104.4 it would have made the table more nearly correct. That item is always in excess of 100 pounds. It takes more than 100 pounds to make 100 pounds of casting. Our records show that it takes about 104 pounds of iron to make 100 pounds of casting. Our weekly reports would show something like that. In other words, there is loss of about four pounds.

Mr. Stantial: Four per cent loss in melting?

Mr. Moore: That is it.

Mr. Johnston: I would like to ask Mr. Moore if he has the men extend the amount opposite their time.

Mr. Moore: The men count their hours, the rest is done in the office.

Mr. Stantial: It is impossible for us to adopt any such system as this on account of the variety of work. It is all very well in a stove or machinery foundry, but where you are turning out all kinds of work you have to keep special costs. I do not see, unless it is getting the general run of castings, how we can possibly apply a scheme like this to our work.

Mr. Ferguson: It has been my experience in the general foundry business, that we have been getting the cost per ton, and once in my experience we tried to get a detailed cost of every individual piece produced in the shop, and after employing this about thirty days—we were running at that time in the neighborhood of 130 molders—we hired a half-dozen clerks to look after the system, and did not consider it a success. I know now of another concern who get individual costs and they handle it in pretty good shape. From my own experience in the general foundry work I never saw the necessity for detail costs. I have always contended that it would cost more money to keep the system running than the gain therefrom. I fail to see any benefit to be gained from detail costs in the general foundry work. In our system we divide the work into four classes. In the first class we put green sand, dry sand and loam work in the second class, hard iron in the third class, and shop tools in the fourth class. The coremakers' time is taken care of in each class. A compilation of that is taken for thirty days, and a report made on that basis always seems to me to be all that can be got out of it. Of course an individual cost system might be beneficial for estimating closer than this other system.

Mr. Sorge: I cannot agree with Mr. Ferguson as far as the keeping of individual costs is concerned. It is not merely for the purpose of estimating. A keeping of individual costs does give a record as to the expense, and if it is done in a proper and systematic manner it can be done with slight expense. I know where the keeping of costs for 120 molders involved the labor of one clerk, and I could have the individual cost of any piece produced

in that shop. As to trying a system of that kind for thirty days I think our chairman will agree with me that that is not a fair trial. Similarly with chemical analyses. He was once connected with an establishment where they tried chemical analyses for a short time and the analyses did not prove a success. Now if you were attempting to make an experiment of thirty days with chemical analyses your results would prove that it did not pay. The same holds good when applied to the cost system. The longer it is kept up the more valuable it becomes. Methods can be judged much more accurately than by the judgment of an individual. I want to ask Mr. Moore a question. He states that he gives a shop number to a certain stove, does that involve every piece of that stove or simply the stove itself?

Mr. Moore: We do not have special shop numbers for the separate parts. There is a multitude of castings, and it would hardly warrant the effort to number each one separately.

I will say that this description of our method is not presented as one which is of general application. It was presented merely with the thought that it might possibly be of interest. The conditions in a stove foundry or in any shop making a specialty are of course radically different from those in a general foundry. It is not to be thought for a moment that a plan that will be satisfactory under one set of conditions is applicable to another set. In the three labor items, the groups II., III., and IX., especially group III., a general labor item, which includes the yard work, cupola tending and grinding, we have found a great variation. When we are running a large heat we need a large number of men, but when the heat is reduced two-thirds, then we have to drop off some of the men, and the practical value of knowing that is worth a good deal. The natural tendency in our shop is that when we are running a lot of men and the heats drop down to 40 or 50 per cent, we drop a man here and there, but we keep three-fourths or two-thirds of the men to do one-half or one-third of the work, and a report of this kind brings that very forcibly to the knowledge of the office. There are some facts in connection with this method which might be of interest. If work comes in, special

work, from outside we attach a shop number to it. The cost of the casting we assume to be practically the same, but the other costs vary greatly. There are special shop order numbers for those items, and we enter them in the ledger accounts, and have them to ascertain the unusual costs on a set of castings. We can turn to the ledger at any time and find the actual expenditure on any class of work done.

Mr. Ferguson: I would like to say a few words on the points that Mr. Sorge mentioned. He said that the keeping of the individual costs was not for the purpose of helping to make estimates on work. I have also had it stated to me when I have asked the question how the keeping of shop costs was going to reduce the cost of production, that it was not for that purpose. If it is not for an economical purpose wherein is there any benefit to be gained from the system? I cannot see anything except a knowledge of the whole working of the concern being placed in the hands of the head of the concern instead of in the hands of the foreman or superintendent and left to his management.

Mr. Sorge: I may have stated what the chairman ascribes to me, but I am under the impression that he did not understand me. It is not merely for the purpose of estimating, but certainly it is concerned in the estimating, and does help in the reduction of costs, and is of as great importance in the very thing that our chairman brought out, as anything, that of informing the head of the concern regarding the workings of the shop.

On motion, duly seconded, a vote of thanks was tendered Mr. Moore for his very able paper.

The discussion of the paper on "Molding Sand," by D. H. Truesdale, was continued, said discussion having been begun at the meeting in Cincinnati, where the paper was read.

Mr. Ferguson: I believe it is due to the members present that I make some explanation regarding this chart (Mr. Loudenbeck's table, shown herewith), and in doing that I will state that as long as I have been in the foundry business I did not know anything about molding sand. I never was familiar with the constituents, and when it was given out that this paper was to be

further discussed this evening I made up my mind that I would find out what was in our molding sand. I had our chemist make an analysis, and this chart is the result of that work:

MOLDING SAND DRIED AT 100° C.

	No. 1—Fine sand for snap work.	No. 2—Medium grade for medium class of work.	No. 3—Coarse sand for heavy machine castings.	No. 4—For heavy machinery in dry sand molds.
Silica	81.50	84.86	82.92	79.81
Alumina	9.88	7.03	8.21	10.00
Ferric oxide	3.14	2.18	2.90	4.44
Combined water	3.00	2.20	2.85	2.89
Cal. carbonate	1.85	1.10	1.10	1.25
Magnesia	.65	.98	None	.88
Potassium	Not es.	Not es.	Not es.	Not es.
Manganese	Trace	Trace	Trace	Trace
Organic matter	Trace	Trace	Trace	Trace
Total	100.00	98.35	97.98	99.27

Mr. Loudenbeck: Four samples of molding sand were taken for analysis which are designated as Nos. 1, 2, 3 and 4. These samples were dried at 100° C. and the dried samples taken for the determination. This gives a sand perfectly dry and easily crumbled. There is still water in the combined form, which cannot be driven out without additional heat approaching a red heat. This is designated as combined water and is combined with the alumina in the form of clay, alumina (see table) being the highest in No. 4. There is one fact that might be explained in this connection, that alumina is not clay. Clay contains alumina, and in its purest form contains about 40%. Clay is a hydrated silicate of alumina, that is it is a compound containing silica, alumina and water. Alumina in itself is infusible and in nature occurs as corundum, ruby and sapphire. It forms a slag when combined with silicia.

Silica in itself is infusible. It occurs in nature as quartz, agate, onyx and sand. All geological formations except chalk, contain silica or silicates. In molding sand part of the silica exists as quartz sand and part in combination as clay. Although silica in itself is infusible, when in combination with suitable bases it forms a slag. The bases that are suitable are alumina, magnesia, calcium, iron, manganese and the fixed alkalies. These combinations are called silicates and have various fusing points, for example:

Silicate of magnesia melts at 2200 deg. C.
Silicate of lime melts at 2100 deg. C.
Silicate of iron melts at 1800 deg. C.
Silicate of manganese melts at 1800 deg. C.
Silicate of alumina melts at 2400 deg. C.

A more fusible slag is a mixture of the silicate of alumina and lime and if potassium is present, the melting point is lowered still more. If lime and potassium are present in molding sand they will readily combine with silica and form a fusible slag at the contact of the melted iron with the mold. As the melting point of silicate of alumina is 2400 deg. C. I hardly see how a slag could be formed at the temperature of cupola melted iron, and I believe if pure quartz sand and clay are the constituents of molding sand, free from all other impurities, no slag will be formed. It is only when the impurities, such as lime, magnesia and potassium are present that the conditions are favorable for forming a fusible substance and it is only when these compounds are in excess that any great trouble would occur.

Considering the iron, I may say I have estimated this as ferric oxide, but may be in the form of ferric hydrate and some, possibly, as ferrous hydrate. I have not had time to investigate this as I would like. When these sands were heated to a red heat they became darker in color, changing from a light yellow to a dark red, indicating some change in the condition of the iron. Iron exists as ferrous oxide in many clays, and if it should be in that condition in molding sand it might form a slag as silicate of iron, which fuses at a lower temperature than silicate of lime.

I have devoted most of this discussion to the fusible constituents of molding sand and have not considered the very important properties, as strength and porosity, and before closing would like to make one statement in regard to the effect of clay on these properties. The confined gases and water vapor must escape, if not readily through the sand then at a point on or near the surface of the casting. The pressure of these gases on the iron while still fluid or in a pasty condition would tend to make a rough casting. A high per cent of clay makes the sand too dense and too strong.

Mr. Sorge: Mr. Loudenbeck does not say whether the calcium carbonate is the normal carbonate or the bi-carbonate.

Mr. Loudenbeck: The calcium carbonate as it exists in nature is usually in the form of the normal carbonate.

Mr. Sorge: My experience has usually been that it has been the bi-carbonate. You will find that if you take the sand after it is washed, the washing contains, frequently, considerable bi-carbonate. The bi-carbonate is very unstable and will give off one portion of carbonate acid, when heated, and is therefore a dangerous constituent in molding sand.

Mr. Loudenbeck: The bi-carbonate as it is found in nature would be washed out and dissolved by the water.

Mr. Sorge: You mean it would not appear in the sand but the water gets it from the sand, it therefore has been in the sand and is constantly being dissolved by water percolating through the sand and consequently is present in the sand. The reason why I ask is because I do not think the mono-carbonate would be as serious a matter in sand as bi-carbonate. The bi-carbonate by giving off one portion of carbonic acid is a serious matter. I have found little pittings in which are inclosed little pieces of white material and at the same time little holes in the iron. It seemed to me to indicate that the bi-carbonate had given off one portion of carbonic acid.

Mr. Loudenbeck: It seems to me that if the calcium existed as a carbonate the heat of the melted iron would be sufficient to

change the calcium carbide to oxide at the portion where the iron strikes the mold.

Mr. Stantial: A number of years ago after a discussion of this kind, I had occasion to make an analysis of sand that was giving the best of results and considered A No 1 sand. I had always understood that the presence of lime in molding sand, over say 2 or 3 per cent, was injurious, or in other words, was fatal to the sand as a molding sand. In this analysis, quoting from memory, there was in the neighborhood of 11 to 12 per cent of lime in that sand. I cannot say whether it was in the form of carbonate or not. It was a first-class molding sand.

Mr. Loudenbeck: The lime in the sand may be there as a sulphate. If it is in that form I see no particular harm in it.

Mr. Ferguson: I can tell a little of my own experience. I was out in Nebraska in a place where there was no molding sand to be had and I had to use something as I did not have money to import it. I took what is known as alkali clay. You will see it where it is covered with a white substance. I do not know what that whiteness was composed of, whether it was lime or what it was. We used that clay, a sandy clay, for molding purposes and I never saw better castings made in any kind of material. The casting made in this way came out clean and nice.

Mr. Sloan: I was going to ask what per cent of lime there was in the sand used by Mr. Truesdale. I always supposed that sand containing 5 per cent of lime would be injurious for molding purposes. I have with me a sample of casting made from sand containing, as near as I am able to learn, from 3 to 5 per cent of lime, and I submit it as a proof that lime does not spoil the sand.

Mr. Sorge: The fact of the matter is that the statement that there is lime in this or lime in that does not explain anything. To judge of the effect of the lime on the sand we must know the exact form of its combination.

Mr. Ferguson: We have a sample of a plate here which was presented to Mr. Sorge by Mr. Truesdale, made in sand without facing of any kind.

Mr. Truesdale: I will state that the pattern for this plate was a little white metal card receiver and the sand would not leave the plain surface, thus the plain surface is a little rough. On the ornamental part the sand left it very clean. The fine lines was what I was trying to produce. It was made with a mixture of very fine sand coming from Zanesville, Ohio, and 60 per cent of pure silica. Both sands were dried and measured.

Mr. Ferguson: I would gather from your statement and judging from the analysis that most of our sand is carrying too much silica.

Mr. Truesdale: I do not think that is good reasoning. That plate would have been better if the sand had been higher in silica. I was afraid to give the man who did the molding an extreme mixture. I was afraid he would play some trick so I made it 60 per cent and stood over him. I would have had far better results if I had had a larger proportion of silica. I wanted to show what could be done in the way of producing fine lines by the use of silica sand. I have had sand brought to me by sand men. They will come in with samples Nos. 1, 2, 3, 4, etc., and will say that they have sand containing about 80 per cent silica and sometimes they say 90 per cent silica. One man said that the sand contained 90 per cent silica and he gave me a sample and I washed it and it only had about 15 per cent silica. I have no chemical knowledge but I am giving my own experience. I have used upwards of one thousand tons of silica sand. The shop I left in Cincinnati used it largely. They used sand containing from 40 to 50 per cent of silica, and sometimes it contained 75 per cent and the results were always satisfactory. I have attributed the success of William Resor & Co.'s castings largely, besides the education of the men, to the use of silica sand. I am adopting it here and am having better and better results every day. I have not got to the end of it yet. It is a long hard fight with stupid molders. They condemn a new thing. I am making progress. I am making better castings than they did before. I did not begin with all the men at first. I picked out about a half dozen who seemed to have more sense than the average run. They con-

demned it at first, now they all want it. The men who opposed it the most are to-day using it gladly.

Mr. Moore: I would like to ask Mr. Truesdale whether in stating that a particular casting was made with sand containing 60 per cent silica, he did not mean that he added 60 per cent pure silica to the sand, so that the actual percentage of silica in the sand must have been 75 per cent or 80 per cent?

Mr. Truesdale: Yes. Mr. Vrooman can tell us how much silica there was in the sand originally. He sold it to us.

Mr. Vrooman: I should say that sand ran about 60 per cent or 70 per cent silica.

Mr. Truesdale: Some years ago we took a contract in Cincinnati for making cornice work and the job came from a machinery foundry where they used coarse sand. The question came up whether we could do it with fine sand. They said we could not do it. I did not believe it and I said I was going to try it. I went ahead, and the result was that we made those castings, weighing eight hundred pounds, domes for furnaces, in the fine sand. Now I know these things from practical experience, but I have no scientific knowledge on the subject.

Mr. Vrooman: I looked at that analysis when I came in and I told Mr. Sorge that I did not believe the alumina item was correct. Mr. Loudenbeck says he does not class clay as alumina. I do not believe there is any sand that contains enough lime, oxides or other foreign matter to do any damage. There is sand dug in all parts of this country under all conditions, and there are all classes of work done by all classes of men, and I do not believe I ever saw a shop where the sand ran together in a slag under melted iron when poured in a mold. At least I have never seen any.

Mr. Ferguson: If you will come up to our shop I will show you some.

Mr. Vrooman: I do not believe it is due to the sand unless the sand contains some vegetable matter. Perhaps you used a casting too heavy for the sand.

Mr. Ferguson: It can be prevented with the addition of sea coal to the same sand.

Mr. Vrooman: I think the whole matter in sand lies in its crystal formation. One crystal may be a conductor of heat and another crystal may be a non-conductor of heat. Silica appears in two forms in the sand—free and in combination. The free silica gives porosity to the sand and the silica in combination adds to the life of the sand in connection with the crystal formation. If the crystal is such that it is a non-conductor of heat it does not permit the heat to penetrate as deep as the sand does whose crystal is a conductor of heat. You coat your sand with a plumbago or some other facing that is fireproof and that does not permit the sand to fuse. Coming back to the question of crystal formation, you have noticed when taking a casting from the mold that you can see a white line showing how far the red heat has lost its life and will no longer combine with water. If you have a sand that is not a conductor of heat then heat will penetrate further from the face of the mold and the sand will burn out sooner. It is not the alumina in your sand that makes it wear longer. It is not because it does not have any calcium carbonate or manganese. It is on account of its crystal formation. I do not believe that you will find iron, or lime or any of those foreign elements, except vegetable matter, that will do any damage.

Mr. Truesdale: Did I understand you to say that sand once heated to a red heat is destroyed? I beg to differ with you. I took some sand and put in one of our big boilers and kept it there for ten hours under a heat of 1500° and took it out and the next morning I took it and molded in it.

Mr. Vrooman: I will take the same argument as with fire brick. Fire clay is about as plastic as anything you can get hold of. If you mold it and put it into the form of a brick and bake it in an oven and take it out and allow it to cool and regrind it, it never will combine with water again. It may be possible that your heat was not sufficient.

Mr. Sloan: Mr. Vrooman has made a statement that fire clay is about as plastic as anything you can find. All fire clay is

not plastic. Fire clay comes from some parts of Ohio, Pennsylvania and is as hard as a rock. Plastic clay makes the poorest brick upon the market. I would like to ask Mr. Truesdale how much facing he used on that plate.

Mr. Truesdale: There was not a grain of facing of any kind used upon it. I used a No. 24 riddle.

Mr. Evans: I would like to ask whether there would be any economy in using a No. 10 riddle rather than a facing.

Mr. Frohman: There has always existed the impression that facings were black. But we manufacture a facing that is called a silica facing which is made from pure silica and ground very finely and bolted. It is practically the same as the sand that Mr. Truesdale is using. It is a question whether it would be cheaper to buy this facing or to use silica sand and use a very fine riddle.

Mr. Evans: If this silica sand is such a fine thing I should think all the foundries in the country would adopt it. It seems to lie with two foundries, one in Ohio and one in Illinois.

Mr. Truesdale: I have had something to do with trying to introduce new ideas to molders. The average molder is not very good at taking up with new ideas. A foundryman will come into your place and see you doing a new thing. He will say that is pretty good, but he will not adopt it.

Mr. Moore: I want to say a word or two regarding the reason why if it is a good thing it has not been adopted by a whole lot of foundries. The fact is that there has been a class of work done in the William Resor Company's foundry which is superior to that done by any other foundry, certainly this side of the Hudson river, and possibly it might be in this country. The reason why the rest of us have not done the same thing is because we have not taken the intense interest they have.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

At the New York meeting (December, 1897) Mr. W. J. Keep presented a paper on "Cast Iron Under Impact," from which we have condensed the following.

The object of the experiments conducted by Mr. Keep was to determine the influence of shock upon cast iron. The kind of shock considered by the author was a blow, which did not produce distortion, delivered on the test bar. Blows were delivered by hammers of various weights, on different parts of test bars, and also by dropping test bars three inches and allowing them to strike endwise on an anvil. Test bars were also subjected to shocks by milling them in a tumbling barrel.

The results show that striking test bars on the side decreases their length, though the decrease is so small that it was found difficult to eliminate errors in taking measurements. Of eleven test bars milled in contact with other castings for half an hour, six had become shorter, four measured the same as when put in, and one had grown longer.

It was found that blows on the end of a test bar shortens it. A blow was first delivered on one end. The test bar was held in a vertical position, its lower end resting on a pine board two inches thick. Half of a broken test bar was held on the end, slanted slightly from vertical, to allow one edge of the lower end to rest across the center of the chilled end of the test bar. One blow was struck on the upper end of the half bar and was transferred to the upper end of the test bar. There was thus little danger of upsetting the end of the test bar. The shortening was five times as great as with ten blows delivered on the side of the same bar with the same hammer. A blow delivered in the same way on the other end showed a shortening only one-fifth of that due to the first end-blow. A piece of lead was then placed on the end of the test bar, and two blows with a half-pound hammer were struck on each end, and the effect was less than the second

single end-blow. On the same lead one blow was struck on each end by a 1¼-pound hammer, with an effect about equal to either of the single end-blows. A blow seems to exert the greatest influence in the direction in which it is delivered. It is difficult to determine whether the shortening which follows an end blow is caused by a general rearrangement of crystals, or by an upsetting of some portion of the bar. If the latter, cast iron is upset by a very slight blow. If farther experiment should show that the casting becomes shorter when struck with a hammer, it will in part explain the frequent cracking of a casting by rapping off the gates, as in the case of a pulley with light arms. If a blow exerts this influence, we can understand the frequent change in shape of many castings. I have a planing machine made to dress pine lumber to 1-32 of an inch thick, and it is very difficult to keep the upper surface of the bed true.

Test bars milled in contact with other castings in a tumbling barrel showed an increase in length. This is in proportion to the malleability of the iron, and is caused by the peening action of the other castings. A test bar ½ inch square by 12 inches long was held in the hand by one end, and 500 blows were delivered with a half-pound hammer on the four sides of one end, the blows not reaching more than one inch from the end. The bar was lengthened .00025 inch. Five hundred blows one inch from the other end lengthened the bar as much more, making it .0005 inch longer. This shows that the peening action of such light blows delivered on the loose end of a test bar for only two inches of its whole length increases its length.

One bar was struck 1,000 blows with a half-pound hammer, on only one side, for four inches in length at the center, until the surface was smooth, the other side resting on an anvil. The bar was .00325 inch longer.

All milled bars are shown to have gained in length. That this is not due to any change in arrangement of crystals was shown by experiments with bars of steel and wrought iron. A tempered steel bar changed very little. The same tool steel, not tempered, was slightly longer. A bar of Bessemer steel lengthened as much

as the cast iron bars. The wrought iron bar was so soft that at the end of one hour the ends were worn round, and the bar was .0012 inch shorter than when put in. At the end of two hours the ends continued to wear rapidly, but the peening of the sides lengthened the bar .00087 inch, and at the end of three hours .00187 inch. It was the action of milling on this non-crystalline bar that suggested the same cause for the action in cast iron.

The author asks the question: Are test bars strengthened by impact? Continuing, he notes that it is difficult to impart shock to a test bar without changing in some way the character of its surface. Attention is called to the following facts concerning cast iron:

It is not an alloy, but a mixture of iron with from 5 to 10 per cent of metalloids. This mixture is partly chemical and part mechanical, and is not uniform.

The strength of a casting is dependent upon the character of its crystals or grains. Large grain, or grains loosely interlocked, invariably produces weakness.

The character of grain depends upon the size of the casting, upon the various local conditions attending melting and the entrance of the iron to the mold, and upon the chemical composition of the metal.

The lack of homogeneity is such that it is a rare thing for even the two test bars which are cast together to have the same strength.

Taking all of these things into account, we must not attach importance to the variation of the bars of any single pair, but must consider averages; or it is better to consider tendencies. If the general tendency of the records of a series of tests is in any direction, it should receive consideration. If there are as many pairs of bars which show an opposite tendency, the fact of the tendency in one direction being greater does not necessarily show that the greater variation is caused by the treatment. One large variation on one side and several small variations on the other may show an average on the side of the large variation, while such large variation may have been caused by some condition that cannot be located, and yet which is not caused by the treatment.

Both tendencies and averages should be considered. If enough tests could be compared, tendencies and averages would agree. When the tendency is all in one direction, without exception, there can be little doubt of its reliability.

The author has proved that milled test bars were always stronger than companion bars not milled. A small percentage showing no gain is credited to the supposition that they become wedged in milling and did not receive the same treatment as the majority. The weakest bars are strengthened most by milling, and the strongest bars gain very little. Exhaustive experiments showed that the strength gained in milling is due to making the surface of the test bar smooth and to condensing the surface by peening. While the removal of the surface weakens a test bar, when the surface is smoothed without any removal of material, a gain in strength is noted.

Mr. Keep referred to a former record, showing that annealing by heat causes a test bar to become longer. If the test bar, before annealing, is weak on account of brittleness, it grows stronger; but if it is not brittle, annealing weakens it.

Total carbon remains the same; most of the combined carbon is changed into graphite. All other elements remain substantially unchanged. In annealing by heat the test bar is heated nearly to fusion, and is thereby lengthened to the utmost extent and held there long enough for the carbon to change to graphite and for the crystals to rearrange themselves. When the casting cools, it does not regain its former length, but is longer than before annealing.

Milling reverses this process, and, by pounding, stretches the sides and presses apart the crystals of the inner portion of the test bar, and increases its total length. In a large number of the bars tested milling slightly increased deflection when measured at 300 pounds. It has just been proved that the increase of strength by milling is largely caused by a removal of the roughness on the surface of the casting, and by rubbing off all notches in the corners of the test bars.

In analyzing milled bars an increase of carbon was noted. In heat annealing the combined carbon decreased exactly as graphite increased, while by milling the increase in graphite came from more carbon being found in the iron.

The conclusion is reached that test bars of gray iron containing the least silicon gain most by the process of milling. Such iron takes a closer copy of the mold, while iron containing more silicon does not burn into the sand as much, and, therefore, makes a smoother surface.

In half-inch bars from any one mixture, up to 3.50 per cent of silicon, each increase of silicon generally adds to strength. The surface being already smoother, the proportionate gain in strength by smoothing during milling is not as great as with bars containing less silicon, which have a rougher surface to begin with. The bars which were protected were smoothed somewhat, but not anything like as much as when unprotected. The test bars which received 5,000 blows on the end were not smoothed, and show no gain in strength.

Mr. Keep states that his paper has no reference to fracture by shock. Resistance to fracture depends upon the cohesion and interlocking of grains and upon the brittleness of the metal. The shock here considered does not change the form of the test bar, and was not sufficient to produce fracture. This paper measures the influence of simple shock by tests of dead load.

If a load be gradually applied transversely to a test bar, it will deflect the center of the bar a certain distance. If the same load is suddenly applied to the same bar, it will deflect the bar twice as much, and if it is not fractured, the test bar will spring back, carrying the load with it, and after ceasing to vibrate, will settle with the load at the point which it would have reached with the load gradually applied. Partially viscous bodies, if not too hard, will not break by a force slowly applied, but if bent suddenly will break. Cast iron takes set at each increase of dead load. How far each grade of iron will resist a load suddenly applied must be determined by a test of each iron.

DISCUSSION.

Wm. Kent and S. L. Kneass discussed some of the points brought out by the paper. Thomas D. West, in a written contribution, took issue with Mr. Keep, and we take the following from Mr. West's comments:

To Mr. Keep's assertion that "It is difficult to determine whether the shortening which follows an end blow is caused by general rearrangement of crystals or by an upsetting of some portion of the bar. If the latter, cast iron is upset by a very slight blow," Mr. West replies:

Experienced founders know that cast iron can be readily upset. Many utilize this characteristic to disguise cracks in castings. This is done not only with cast iron, but with steel as well. Castings that would have been condemned on account of cracks, could the engineer or inspector have seen them, have been closed up so neatly by means of peening that the man doing the job could not readily tell where the crack was, from appearances. It is a common thing in founding to flatten out portions of a gray iron casting. The softer the iron, the more readily this is done. The blows that shorten a piece of iron can also lengthen it, with tact in peening. Crooked castings are often straightened out by merely peening the concave surface. The two facts just cited illustrate the principle involved, permitting Mr. Keep to lengthen or shorten thin bodies of cast iron.

The paper further says, "If further experiment should show that the casting becomes shorter when struck with a hammer, it will in part explain the frequent cracking of castings by rapping off the gates, as in the case of a pulley with light arms. If a blow exerts this influence, we can understand the frequent change in shape of many castings." Mr. West's views on this point are that the cracking of pulley castings is not due to any change in length by reason of rappings, but to the difference of proportions in castings causing unequal contraction of parts. Jarring by a blow causes the part stretched or held in union by strains to separate, thus giving cracked castings. This is often shown by changes in the temperature of the atmosphere causing castings to crack of

their own accord, that had never received blows of any description.

Mr. West takes exception to the statement in Mr. Keep's paper that "half-inch bars from any one mixture, up to 3.50 per cent of silicon, each increase of silicon generally adds to strength," and contends that this is virtually a claim that a half-inch square bar will show the strength of any or all grades of iron, in agreement with the actual results found in testing strength by tensile strain, hydraulic pressure, etc. Mr. West says that he has never seen a series of tests with half-inch bars, ranging through the different grades of iron (or even in one grade alone), that showed the uniform increase in strength, from the weakest to the strongest iron, which is displayed by bars of larger size. To illustrate this Mr. West appends the following table:

TRANSVERSE AND TENSILE TESTS OF SPECIALTY MIXTURES.

Specialty Mixture.	Transverse Strength 1 1-8 in. Round Bars. lbs.	Tensile Strength 1 1-8 in. Round Bars. lbs.	Transverse Strength 1-2 in. Sq. Bars. lbs.
Gun Metal	3,686	37,100	398
Chill Roll	2,980	30,100	265
Heavy Machinery	2,657	28,676	395
Car Wheel	2,553	23,270	277
Light Machinery	1,931	21,120	454
Stove Plate	1,798	17,150	160
Sash Weight	1,406	7,125	167

Mr. West says: "A study of this table shows that ½-inch bars are very erratic, with results quite unlike the uniformity in the increase of strength exhibited by the 1 1-8-inch round bars. The transverse tests were obtained from bars tested 12 inches between supports. All tests here given are from solid bars, and are taken from a series of 100 tests which the writer presented in a paper on specialty mixtures about two years ago to the Western Foundrymen's Association. The test bars were cast by some of our leading foundries and tested by authorities in such a manner that the figures presented can be supported as reliable. The transverse

and tensile strengths of the 1 1-8-inch round bar will be found a most excellent guide for any desiring co-efficients of strength of cast iron in its various grades as coming from practical founding. The table also exhibits what the writer claims is the most practical way to conduct a series of tests, to indicate the fitness of any size or form of a test bar to indicate most accurately the strength of cast iron. The reason for ½-inch square bars being so erratic is the fact that when such small bodies of iron are cast in green sand molds, the state of the carbon and the physical qualities are too easily affected by differences in the 'temper' of molding sands and the fluidity of the metal at the time molds are poured. We have but to refer to Mr. Keep's own paper to prove that light bodies, as of ½-inch square bars, are greatly affected by variations in the 'temper' (dampness) of sand and fluidity of metal."

Referring to some of the tables in Mr. Keep's paper, showing that with the same ladle of iron there are differences owing to varying fluidity of metal amounting to 65, 86 and 68 pounds in ½-inch bars possessing an average strength of 381 pounds, Mr. West says that in the pouring of two different heats, we can have an error, in recording strength, from what is really the same mixture or grade of iron, of nearly 20 per cent. Carrying this up to 1-inch square bars, should they be as erratic as ½-inch bars, we would have the same mixture or grade of an iron running 2,500 lbs. one day and 3,000 lbs. the next, presenting an error of 500 pounds from what is the actual condition. The writer knows from research that such a difference does not exist with round bars 1 inch square in area or over, and could point to experiments which he has made with variations in fluidity of metal to prove that test bars as large as 1 inch square in area, when cast in the round form especially, show very little difference. In the square form, on account of the corners with their chill, a difference of 5 per cent in some cases may be found. Mr. Keep says: "I have proved before that iron last poured from a ladle will make stronger test bars than the iron poured first." Mr. West has found the reverse to be true in some cases, but claims that the grade of iron used and the size of the test specimen (on which latter depends in

turn the percentage of graphite or combined carbon) determine whether test bars are stronger or weaker with the last pour from a ladle.

Mr. West continues: "Anyone who is familiar with founding knows that as a rule in the same shop, no two days will show the fluidity of the metal exactly the same, saying nothing about the great difference that must exist between different shops and which can be such as to cause a wider difference in the strength of test bars in the same mixture than Mr. Keep's figures show. Any giving this subject study can readily see the wisdom of using test bars that are least apt to be affected by changes in the fluidity of metal, whether for the records of one's own shop or for comparison with others. The evil of irregularity in the fluidity of metal, it is to be remembered, is not all that prevents small test bars correctly recording the strength of iron. When we consider that variations in the nature and 'temper' of molding sand are as influential in making small test bars erratic, both combined are certainly not to be ignored by anyone who would adopt what is best to record most accurately the strength of cast iron."

Mr. West does not question Mr. Keep's tests on shortening or lengthening bodies of iron by milling where test bars are used in pairs for comparative purposes. Two bars cast together in the same flask admit of a comparison one with the other, which is impossible with bars cast from two different "heats." Mr. West contends, however, that this is wholly different from what is implied in the statement of Mr. Keep, "that in half-inch bars from any one mixture up to 3.50 per cent of silicon, each increase of silicon generally adds strength."

MACHINE MOLDING WITHOUT STRIPPING PLATES.*

By E. H. MUMFORD.

Molding machines may be classed under three heads. First, machines which only ram the molds, and, when the ramming is done by means of a side lever, by hand, are generally called "squeezers." Second, machines which only draw the patterns, the ramming being accomplished by the usual hand methods. Third, machines which both ram the molds and draw the patterns, ramming either by a hand-pulled lever or by fluid pressure on piston or plunger and drawing the patterns through a plate called a "Stripping Plate" or "Drop Plate"—till recently the usual method—or, without the use of this plate fitting everywhere to pattern outline at the parting surface, the patterns being effectively machine guided in either case.

It is to the third class that the machine which is used to illustrate the subject of this paper belongs, and which would seem to have enough that is novel in the application of machinery to the foundry to merit the attention of the Society.

At the risk of appearing pedantic, but with a view to developing an appreciation of the true function of the method of pattern-drawing used in this machine, attention is called to the following sectional views of molds and ways of drawing patterns occurring in machine molding. Fig. 1 shows an ordinary "gate" of fitting patterns being drawn from the drag or nowel part of the mold by means of a spike and rapper wielded by the molder's hand after cope and drag have been rammed together on a "squeezer" and cope has been removed. Frequently the pernicious "swab" is used to soak and so strengthen joint outlines of the sand before drawing patterns, in such cases as this. In this case, before cope is lifted, these patterns must be vigorously rapped through the cope; an amount depending (and so does

*Paper read at the New York meeting (December, 1897) of the American Society of Mechanical Engineers.

the size of the casting) upon the mood and strength of the molder.

Fig. 2 shows the Stripping or Drop Plate method of drawing patterns.

FIG. 1.

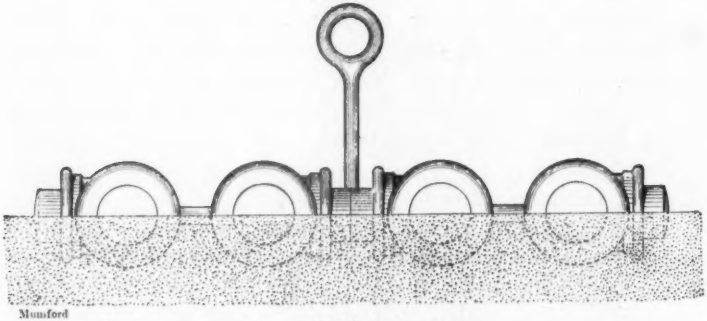
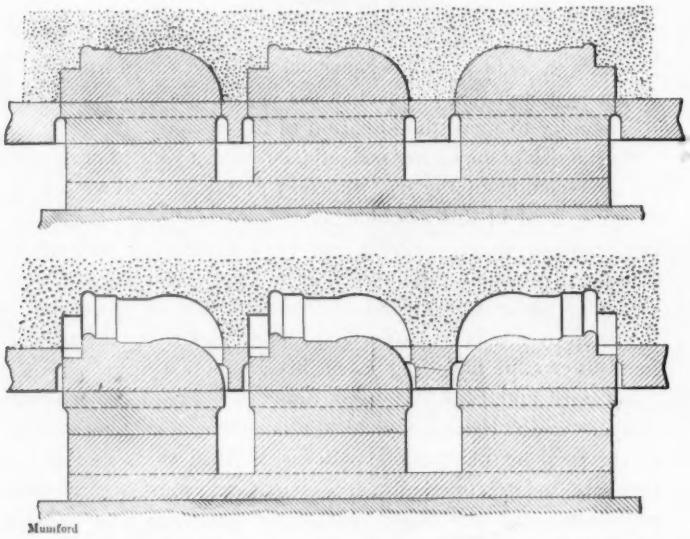


FIG. 2.



In this method, the patterns are not rapped at all and are drawn in a practically straight line so that the mold is absolutely pattern size.

The stripping plate is fitted accurately to every outline at the joint surface of the patterns, obviously at considerable expense, and, of course, at the instant of drawing the patterns, supports the joint surface of the mold entirely. This is, at first sight, an ideal method of drawing patterns, and it has for years

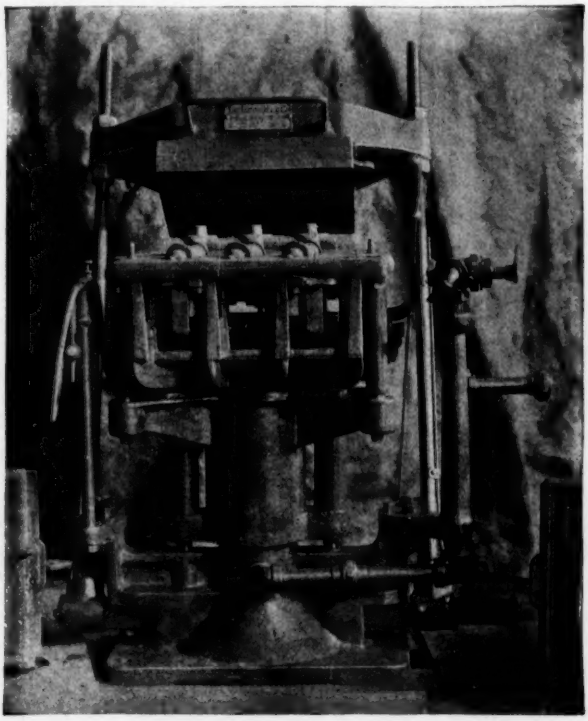


FIG. 3.

been the only method practised on machines. It has two disadvantages. The patterns are separated from the stripping plate by the necessary joint fissure between the two. Fine sand continually falls into this and, adhering to the joint surfaces more or less, grinds the fissure wider. This leads to a gradual reduction of size of patterns on vertical surfaces and a widening

of the joint fissure often to such an extent that wire edges are formed on the mold, causing, on fine work, "crushing" and consequently dirty joints. A nicely fitted but worn plate of twenty-four pieces, which had cost, at shop expense only, $250, was recently replaced by a plate of twenty-eight pieces, fitted ready for

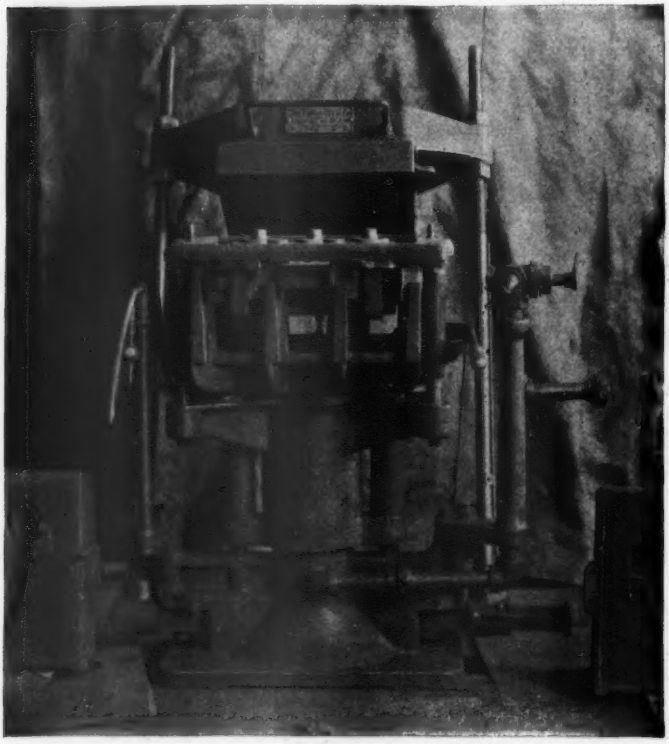


FIG. 4.

the machine under the new system about to be described, for not more than $25.

The Stripping Plate method has another drawback, not always appreciated, probably because accepted as inevitable. Stripping Plate patterns are not rapped, and there frequently occur on

surface of patterns, remote from the action of the stripping plate, rectangular corners just as important to mold sharply as those at the parting line. Such corners have either to be filletted or "stooled" in stripping plate work, and neither method often

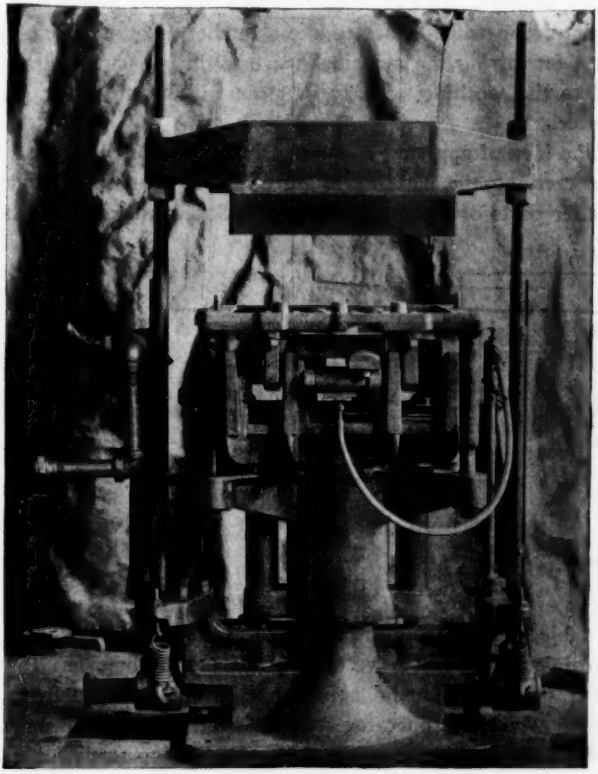


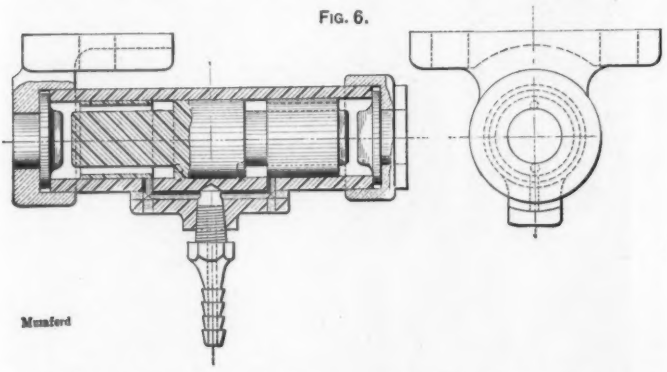
FIG. 5.

is practicable. When the entire pattern and plate are vibrated so that the corners where the pattern joins the plate draw perfectly, as they do in the machine to be described, it is obvious that similar corners anywhere on pattern surface will draw equally well.

The vibrating of patterns, or rather of molds, during the operation of drawing the patterns possesses little of novelty. Ever since a bench molder's neighbor first rapped the bench while he lifted a cope or drew a pattern, the thing has been done in one way or another. In fact, machines are now and then found on the market in which a device like a ratchet or other mechanical means for jarring the machine structure during pattern-drawing renders the working of easy patterns without stripping plates possible.

The idea of applying a power driven vibrator directly to the plate carrying the patterns to thus vibrate them independently of other parts of the machine and the flask and sand, has been

FIG. 6.

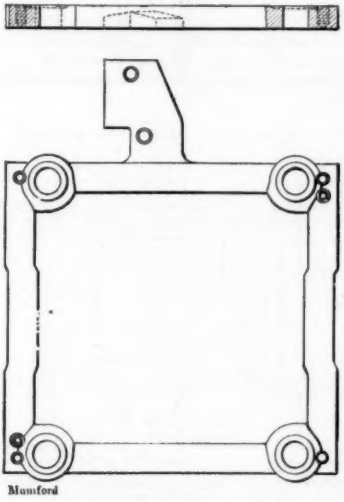


the subject of the issue of patents to Mr. Harris Tabor, and the following figures will serve to illustrate the mechanism. Figs. 3 and 4 show the general appearance of the machine from the side on which the operator stands. Fig. 3 shows the machine ready to receive the flask, the patterns being up ready for molding. Fig. 4 shows the machine after patterns have been drawn and flask lifted off.

Briefly, the operation of the machine is as follows: The ramming head shown thrown back at the top of the machine is drawn into a vertical position, after flask has been placed and filled with sand. The 3-way cock shown at the extreme right is then quickly opened, admitting compressed air of 70 to 80 pounds

pressure to the inverted cylinder shown at the center of the cut. The cylinder with the entire upper portion of the machine is thus driven forcibly up against the ramming head flask, sand and all. Often a single blow suffices to ram the mold—often the blow is quickly repeated, according to the demands of the particular mold in hand. Gravity returns the machine to its original position, as the 3-way cock opens to exhaust. After pushing the ramming head back and cutting sprue, if the half mold is a cope, the operator seizes the lever shown just inside the 3-way cock

FIG. 7.

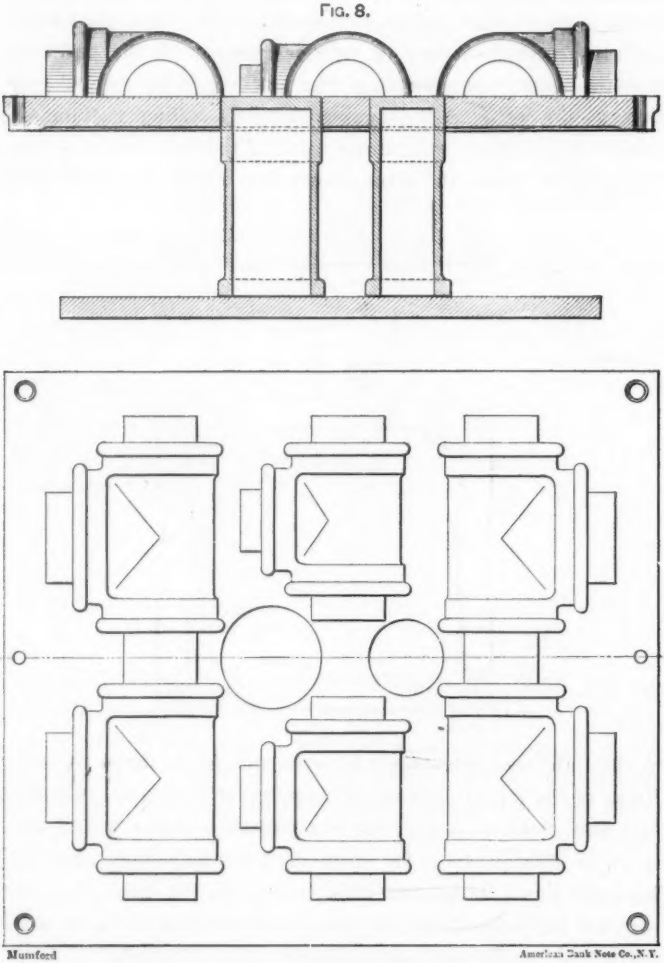


at the right, and, drawing it forward and down, raises the outer frame of the top of machine containing the flask pins, with flask and sand thereon, away from the patterns—thus drawing them from the sand. Just as he seizes the pattern-drawing lever with his right hand, he presses with his left on the head of a compression valve shown at the left side of top of machine, thus admitting air to the pneumatic vibrator already referred to.

Fig. 5, a rear view of the machine, shows, at the top center, with its inlet hose hanging to it, this vibrator which is shown

in section in Fig. 6. It consists simply of a double-acting elongated piston having a stroke of about 5-16 inch in a valveless

Fig. 8.

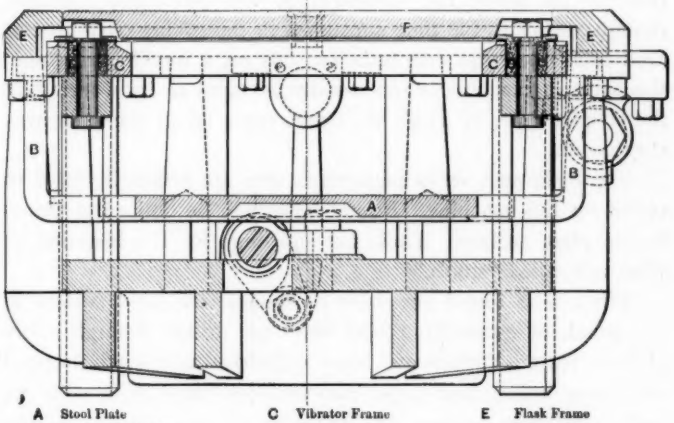


cylinder, and impacting upon hardwood anvils at either end at the estimated rate of 5,000 blows per minute.

The method of communicating the rapid, yet small oscillations of the vibrator to the patterns and yet keeping them from being transmitted to the rest of the mechanism is this:

A frame, called a vibrator frame, to which the pneumatic vibrator is bolted and keyed is shown in Fig. 7. To this frame the plate carrying the patterns, often, in cases of patterns having irregular parting lines, forming one and the same casting with the patterns, is fastened by the four machine screws, the small tapped holes for which are shown in the corners. In fact, in changing patterns, the process consists of simply removing these

FIG. 9.



A Stool Plate
B Stool Plate Brackets
C Vibrator Frame
D Elastic Bushings
E Flask Frame
F Pattern Plate

Mumford

four machine screws, taking up the pattern plate and screwing to the vibrator frame the new pattern plate. The vibrator frame itself is secured to the machine structure by the four larger bolts, the holes for which are shown in the inner corners. These bolts are, as shown in Fig. 9, surrounded by thick bushings. These bushings are elastic to such a degree as to absorb the sharp vibrations of vibrator frame and patterns, while so firm and well-fitted as to hold patterns accurately to their position.

The action of the vibrator is such as to give the entire pattern surface an exceedingly violent shiver, making it impossible

that any sand should adhere to this surface, while the magnitude of the actual movement of the pattern is so slight that it is found to fill the mold so completely that it is impracticable to draw it a second time without rapping. Yet, so truly are the patterns held, and so little disturbed from their original position, that it is perfectly practicable to return patterns to a mold having the finest ornamental surface in the ordinary practice of "printing back."

In cases where deep pockets of hanging sand occur, which cannot be held during lifting off and rolling over, machines are arranged to roll the flask over in their operation and draw the patterns up under the influence of the pneumatic vibrator, though, owing to the time consumed in the rolling over process (and each operation counts in seconds on a molding machine) this style of machine is not usually as rapid in its working as the simpler type, in which the flasks come off in the same way they go on.

Fig. 8 shows a set of patterns as they are ordinarily fitted to plates for this machine. Round holes will be noticed at places in the plate surface. These are openings for the insertion of what are called "stools."

When it is found necessary to support the sand surface at any point, or generally, round holes are drilled through either plate or pattern surface and loose cylindrical pieces are dropped into these holes, their upper end surfaces being flush with the plate or pattern surface and their lower ends resting on the plate called, from this use, a stool plate. This plate appears in Fig. 9 at A and is hung solidly by the brackets shown at B from the frame which carries the flasks, so that it has the same upward motion as the flasks, and the upper ends of the stools remain in contact with the sand of the mold until same is lifted from machine. Fig. 9, showing a vertical section through a machine, will make perfectly clear the position and action of these stools.

As illustrating the importance of being able to work without stripping plates on a line of work which is much more extended

than that possible with them, we may say that a machinist with a drill press, supplied with split patterns and planed pattern plates has matched and fixed five sets of from four to eight pieces in a day; and wooden patterns fitted for temporary use in the same way, are of frequent occurrence when it is not thought wise to go to the expense of metal patterns on account of the relatively small number of castings to be made from them.

It is not, perhaps, too much to say that pattern expense is not the final evil of the costly and not durable stripping plate patterns.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

THE ALUMINUM WORLD.

The Aluminum World has the following article on "The Use of Aluminum in the Brass Foundry":

The recent increased use of aluminum by people heretofore manufacturing brass castings without the use of this metal, has attracted considerable attention, and it is the object of this article to deal briefly with some of the advantages which can be derived by the use of aluminum in brass, and also how it is used.

First taking up the question of aluminum bronze, which is simply an alloy of copper and aluminum, in proportions varying all the way from 89 per cent copper, and 11 per cent of aluminum, to larger proportions of copper, and as small a percentage as four, of aluminum. This series is known as aluminum bronze and forms probably the strongest metal which is known in the arts. Owing to the large percentage of copper which this contains, however, it is not feasible to use this as a substitute or in competition with brass, and this metal is used principally where great strength is required, or where great strength and a non-corrosive metal are desired. Aluminum bronze probably is affected less by acid than any of the so-called "acid metals." This is also true of the action of salt water upon it, as has been shown by elaborate experiments which have been conducted by the government as well as some private individuals. Aluminum bronze is also used for bearing metals where a good anti-friction metal is required. The method of introducing aluminum into the copper for the purpose of manufacturing aluminum bronze is one of the principal secrets in the successful manufacture of a good bronze, and has been previously described in these columns.

Taking up the question next of aluminum brass, the percentage of aluminum which is used varies from one-tenth of one per cent to a 10 per cent mixture. The lower percentage of aluminum in brass is used more particularly to give the brass additional

fluidity, and consequently enabling castings to be manufactured which will appear sharp and clean, and results can thus be obtained by the use of a very small percentage of aluminum, which it is impossible to obtain with the ordinary brass mixtures without its use. Also it is possible to use a cheaper grade of zinc when some aluminum is added and considerable strength is required, providing the zinc does not contain too much lead as an impurity. The presence of much lead in zinc, when the most inferior grades of zinc are used with aluminum, causes the lead to sweat out on the surface of the castings and discolor them. When this action takes place, however, it is by all means advisable for the foundryman to change his brand of zinc, for such zinc used without aluminum is hardly worthy of the name.

The way in which aluminum should be added to brass is to first make a mixture of aluminized zinc of some standard percentage. This aluminized zinc generally contains 10 per cent of aluminum, and is made by taking a plumbago crucible and melting in it 10 pounds of aluminum. After the aluminum is melted, zinc should be added as fast as the molten metal will take it up, until all of the 90 pounds have been added. Then the crucible is removed from the fire and the contents cast into molds of convenient form and size, which can afterwards be broken up and this aluminized zinc introduced into the copper with the other zinc, and in such proportions as will give the required amount of aluminum in the finished casting.

When aluminum is used as previously stated, in small percentages, from one-tenth to two-tenths per cent, that is, from two to four pounds of aluminum to a ton of brass, its action is more toward clearing the metal of impurities and giving additional fluidity, rather than giving additional strength, and it is not until one-half of one per cent is added that an increase of strength is secured in the finished casting. In some electrical work the higher grades of aluminum brass have been very successfully and advantageously used for such work as the brass casting made in connection with the over-head trolley work, where a great deal of strength is required. These castings are desired of such

strength that they will withstand the enormous strain brought on them, and the breaking of the same will of course inconvenience the working of the line.

Aluminum brass is also being used by the United States navy in some of their finer work, and some of the shipbuilders are now supplying it very largely, as they find that they can afford to do this at their own expense, owing to the rigid inspection which the government gives the work, and by the very small number of castings which are rejected, owing to the use of aluminum in their brass, it more than repays them for any additional expense which they have gone to in the matter. It has also been found by careful experiment that the introduction of aluminized zinc in brass causes a much smaller loss in the zinc than if aluminum is not used; that is, it seems to prevent to a certain extent the zinc burning or volatilizing, should the metal become over-heated, which is always the case to a certain extent, for it is never possible to weigh out of the crucible as much metal as has originally been placed in it.

A good deal of brass is now made and used in connection with acids, and is known as "acid brass," and contains copper, tin, lead and antimony. This, properly speaking, is more nearly a bronze than a brass, and it is possible to manufacture with copper, tin and a small amount of aluminum, a brass which seems to be superior in withstanding the corrosion of most acids. The percentage of copper which is used is a little more than is ordinarily used, and the percentage of tin less. The use of aluminum is found to be particularly advantageous in working over old gates and scrap which naturally accumulate around a foundry, and that may have dirt and impurities in it, which would ordinarily make it almost impossible to pour and cast in any satisfactory shape. It is on the same principle, as above stated, that more satisfactory results can be obtained by the addition of a small amount of aluminum when inferior zinc is used in brass.

Some of the large brass mills that are manufacturing sheet, now use a small amount of aluminum in their sheet brass, as it seems to enable them to cast their ingots more perfectly and

enable them to roll not only a stronger sheet, but one with a more perfect surface than can be obtained without the use of aluminum. This whole subject, however, of the use of aluminum in casting brass is to a certain extent new to the majority of brass foundries and is little talked of by those who do use it, for the reason that where they have secured advantageous results they have kept it to themselves and have endeavored to reap the benefits which would naturally accrue to them when there is very close competition.

In first attempting to use aluminum in brass foundries there will, of course, be more or less difficulties to be overcome, owing to the men not being familiar with and knowing exactly how to handle the metal; but the principal reason for not meeting with complete success is because the aluminum is not properly introduced, and in order to obtain the best and most satisfactory results it is absolutely necessary that it should be introduced as above described. This is principally from the reason that copper melts at about 2,000 degrees F., and if a small amount of aluminum which melts at about 1,200 degrees F. is introduced into a large volume of copper, it comes to the surface and is oxidized, and the full advantage effected by the aluminum is not felt. And again, if any of the aluminum does oxidize, some remains in the brass or bronze, as the case may be, in the form of an oxide of aluminum, a white powder which will show out on the surface of the metal if it is turned to a finished surface, or if the metal is rolled into a sheet and then polished.

If, however, the aluminum is properly introduced, there is no reason at all why any of it should be oxidized, and a most perfect surface can be obtained, and the finish on such a metal is of a higher quality than can otherwise be secured. It is to be noted, however, that it is not desirable to use aluminum in brass which is to be dipped, for the reason that the introduction of aluminum gives the brass an acid-resisting quality, and no matter how small a percentage of aluminum is used in brass, if it is intended for dipping purposes the effect of it will be quite apparent, and it is impossible to obtain such a finish as if no aluminum

were used. But this very quality makes the presence and use of aluminum in brass particularly advantageous and desirable for any place where the brass must be used to withstand corrosive action, either from acids, water or salt air.

In making brass castings, owing to the additional fluidity mentioned above, it is possible to increase the number of patterns on the gate, where a lot of small castings are being made from one-third to one-half over what can be cast if no aluminum is present. This is one of the principal advantages and uses for aluminum in brass castings, where the aluminum is only used in very small quantities. The presence of aluminum in either brass or bronze tends also to change its color slightly. The larger percentage of aluminum that is used, the lighter the finished article will appear. In the case of aluminum bronze, 95½ per cent copper and 4½ per cent of aluminum will give a color which is almost impossible to detect from 14 karat gold, and there is today a large line of table flat ware which is manufactured and sold on the market under the trade name of "Gold Aluminum," which has this color. It is to be noted, however, that the addition of very much aluminum will materially increase shrinkage, and this should be provided for in casting work by using larger gates and higher risers.

In saddlery hardware, especially, where a great deal of brass is used, and used in very small articles, the addition of aluminum has been found to be particularly desirable, for, owing to the very close competition, the manufacturers of this class of goods have been obliged to use a very poor grade and cheap quality of brass, and by the addition of a small amount of aluminum they are not only able to get a casting which is stronger and superior in quality, as far as actual strength is concerned, but they are enabled to cast more pieces from a single gate or flask, and consequently considerable time is saved in making up the molds for such articles, and the saving thus accomplished forms a large item in the competition which is to be met, owing to the reduced foundry cost of the article manufactured by the use of aluminum.

It is to be noted in both the alloys of copper, zinc and

aluminum, and also copper and aluminum, that the use of too much aluminum will give a very brittle metal. On the copper end of the series the dividing line between the strong and the brittle alloys seems to be exactly at the point where a very decided change in color takes place; that is, where the metal changes from the yellow color of gold to the white color of silver, and this change takes place in a mixture containing between 80 and 85 per cent of copper. Alloys which contain more aluminum than this, as for instance, 25 or 30 per cent become so brittle that they will break if they are dropped on a stone or iron floor, and the machining also becomes very difficult, as the metal chips and does not turn smoothly. In some special cases these higher alloys can be used—if no strength under a blow is required. They have a very hard surface and take an excellent finish.

It is also to be noted that with the use of very much aluminum, that is, for percentages from 1 to 2 per cent in either brass or aluminum bronze, that the strength increases to a very noticeable extent on the second and third melting. This is accounted for by the fact that a more perfect alloy is formed between the metals and the aluminum on each successive melting. Taking, for example, ordinary castings of 90 per cent copper and 5 per cent tin and 5 per cent aluminum, on the first melting these withstand about 41,000 pounds per square inch, as their ultimate tensile strength. These castings on the second melting withstand nearly 43,000 pounds. Mixtures of 10 per cent copper and 10 per cent tin usually give only from 33,000 to 34,000 pounds, as their ultimate tensile strength; and when these proportions are increased to 20 per cent of each metal the tensile strength is only about 2,000 pounds, and the metal is found to be extremely brittle. The maximum shearing strength of the copper, aluminum, tin alloys is also about the point of the maximum tensile strength, that is, where there is from 5½ to 6 per cent of each metal present. The maximum tensile strength of aluminum bronze is also at about the same point as the amount of total alloyed ingredients, that is when it contains from about 1 to 10 per cent of aluminum.

It is to be noticed that the addition of about 6¼ per cent each of aluminum and tin to copper increases the tensile strength nearly three times and makes it a very much harder and a denser metal, and consequently of more value in the arts. There is one point to be noted, however, and that is, when very much aluminum is used, it makes the metal a little more difficult and expensive to work, if very much tooling or machine work is to be done on it; but as this is generally a secondary consideration; where much strength is required, it is of but little importance, as the great bulk of aluminum which is used in connection with brass is used principally for giving additional fluidity and enabling the foundryman to use cheaper metals and secure better results than could possibly be secured by the use of the same metals were aluminum not used.

AMERICAN MACHINIST.

Dec. 2.—L. C. Jewett illustrates a method of casting large gear segments.

Dec. 16.—K. K. writes of "Mitis Founding," this time taking up the melting, charging and mixing of same.

R. D. Moore discusses "Centrifugal Skimming," and offers some suggestions obtained by long contact with the foundry.

Dec. 23.—K. K. describes further experiments on melting wrought iron.

Dec. 30.—Wm. Newton illustrates a method of casting a furnace door lining.

THE FOUNDRY,

The foundry of the Westinghouse Air Brake Co. at Wilmerding, Pa., is illustrated in the December issue of The Foundry, by W. E. Wilkes. The author furnishes a complete description of the plant througho it, and as this is one of the few concerns who have specialized the manufacture of intricate castings, there are shown a number of innovations, differing decidedly from ordinary practice.

Referring to recent published items concerning the making of cores in German foundries by adjustable machines, this paper says:

On the surface it would appear to indicate that American foundries are not "up to snuff" like their Teuton competitors, but when we look closer at the question it will be found that the reason we have no machines for making stock cores, is because we have no use for these. A few years ago, whenever a straight core of any kind was wanted the molder used to caliper his pattern, procure a file and an old piece of a saw and betake himself to the core bench, where he would file out such cores as he wanted. To-day every pattern is furnished with core boxes of its own, at least it is in shops making any pretensions to economical production. The cores come from the coremaker's hand ready to be set in the mold, and fit like two and two make four.

We have discarded stock cores because the making and using of these was saving at the wrong end. The time occupied by the molder in calipering, filing and fitting the cores for a mold has often cost more than the price of making the core-box, besides leaving that chance for inaccuracy so apparent in all cut and try methods. It costs less to make a set of core-boxes for the average pattern than it does to fit the cores out of the stock pile. Adjustable machines for making cores have the knack of consuming more time in adjusting than they save in making boxes. Adjustability is nice enough in some places, but in core-making there is nothing like having things made to order. It pays there to have things so they will fit without argument, persuasive or muscular. We may be behind in some respects, but certainly not because we have done away with that old time eater, the stock core.

In some "Notes on Malleable Iron," W. H. Kane says:

For light castings the iron should be the higher in silicon, as this increases the fluidity; the average percentage of this metalloid in a mixture calculated for that class of work should be at least 1 per cent, which, together with from .35 to .40 per cent of manganese, will give, if properly annealed, a tensile strength of

from 39,000 to 44,000 pounds per square inch and an elongation from 4 to 7 per cent. For couplers and heavy work the amount of silicon in the mixture should average three-quarters of 1 per cent (.75) and manganese about one-half of 1 per cent (.50). The following tests from a number of heats, besides giving the tensile strength and elongation, also show the amount of silicon and manganese as found in the mixture before melting and the amount of these metalloids found in the casting before annealing:

	Per cent of Silicon in		Per cent of Manganese in			
Heat.	Mixture.	Casting.	Mixture.	Casting.	Tensile strength pounds.	Elongation per cent.
A	.98	.59	.52	.29	49,547	6.83
B	.92	.54	.49	.24	49,637	6.33
C	.97	.57	.49	.22	47,885	7.16
D	1.00	.78	.48	.35	44,640	5.50
E	.90	.58	.57	.29	49,700	8.16
F	.90	.59	.57	.38	49,849	8.33
G	.78	.52	.58	.31	50,060	6.16
H	.79	.53	.64	.48	52,460	4.50

The average amount of iron melted at these heats was from seven to eight tons and the mixture, made expressly for heavy work, consisted of 40 per cent Sprues, 40 per cent of coke irons, 15 per cent charcoal iron, and 5 per cent of malleable scrap, and made very fine malleable castings. The cost of these varies greatly, as economical production depends largely upon successful manipulation of the foundry, where I have seen the cost of labor alone vary from twenty to forty dollars per ton of output. At the present time there is nothing to prevent malleable iron being made according to specifications, although the same mixture will not work the same in the furnace on all occasions.

The iron should be puddled as soon as it starts to melt, say an hour and a half after charging, and every fifteen minutes there-

after. A furnace of eight tons capacity, working well, should be ready to skim in two and a half hours after charging.

Some foundries only skim the metal once, while most of them prefer to skim it twice, and I think this is the most practical. After being skimmed the last time, the iron should be given enough time (say from ten to twenty minutes) to regain its heat before being tested. As soon as the test shows the carbon in the iron to be in the combined state (white iron) the metal should be tapped, providing it is hot enough. If it takes more than twenty-five minutes to empty the furnace, care should be taken to shut off the blast from the top tuyeres, as the blast will tend to reduce the percentage of silicon and manganese in the iron after the carbon is combined. A large sprue should be poured, when the furnace is half empty, and after being sand cooled should be used as a test piece to determine the amount of graphitic carbon present. For heavy work, a sprue two inches in diameter makes a reliable test piece; for light work a smaller one should be used.

The annealing and other operations connected with the production of malleable castings vary but little in the different works. A few have annealing furnaces in operation where neither pots nor packing is employed, though this method causes the casting to scale from contact with the air. Such works generally confine their operations to turning out castings for their own use, and do not need to be so particular about appearances as they would if placing their product on the market. The rapid growth of the use of malleable castings in car construction has been brought about principally through a constant reduction of their selling price. The great difference in cost between gray and malleable iron castings has disappeared, being at the present about one and one-quarter cents per pound, though when it is considered that a casting made of gray iron may be reduced as much as 60 per cent in weight, if made of malleable iron, this difference quite disappears when the net cost is considered.

The prices obtained for malleable iron castings have been greatly reduced during the past three years. This is to a certain extent due to improved facilities cheapening the cost of produc-

tion, while it is also true that the manufacturer's profit has been scaled down so low that but little remains on which to base a further reduction of cost without sacrificing all profit. As every advantage is taken in the purchasing of material, and as the wages paid has reached a plane where further reduction is considered impossible, and likewise there can be but little hope of any great improvement in foundry facilities, while the cost of selling is increasing owing to competition, there is a danger the quality will be sacrificed in the attempt to lower the selling price of these castings. Rough molded castings full of blow and shrink holes, the last, the most important defect to be guarded against in the manufacture of malleable castings, as well as poorly annealed and badly bent or twisted out of shape castings, may be produced for less money, but the purchaser will in the end be the loser. Good malleable castings never have been and never will be produced as cheaply as gray iron.

In connection with the low prices at which malleable iron is sold, it is strange that the demand actually exceeds the supply. Most of the malleable iron works which have come under my notice are at the present writing a month behind orders. While a raise in the price of raw material may advance the cost of malleable castings, it is also a fact that several of the chief manufacturers have contracted for a large amount of work at present prices.

S. S. Knight criticizes some of the claims made for the Doherty process. We reproduce the article herewith:

Having been asked to review the various articles that have appeared in the trade journals from time to time concerning the above process, and having done some actual work upon the same, it is with a most positive assurance that nothing but truth will stand investigation that I attempt to point out some of the virtues and to denounce the absurd claims made by many writers upon this subject whom I am sure have never more than seen a cupola, and are totally ignorant of its operation.

The claims made for this process may be, for convenience, treated under two heads—first, those pertaining to a more eco-

nomical operation of the cupola furnace; second, those that pertain to the amelioration of the quality of the metal.

Under the first head we will note the saving in the amount of fuel used which is one of the alleged main features of this process. I here will quote from an article which appeared in the November Foundry: "A saving in quantity of fuel used is effected as the hydrogen flame is 4.28 times as hot as the ordinary carbon flame; and as oxygen is a strong supporter of combustion, the gases obtained from the decomposed water, play an important part in melting the iron placed in the cupola, thus effecting a saving in the quantity of fuel required to melt the iron. For the same reason an inferior grade of fuel may be used."

A few observations upon this claim will no doubt prove at least that the wording is misleading. In stating that the complete combustion of hydrogen with oxygen developed 4.28 times the quantity of heat that the burning of the same amount of carbon to anhydrous carbonic acid would, only partly tells the story. It must be remembered that heat is but a form of energy and is directly dependent upon molecular motion; and since energy is uncreatable and indestructible, the amount of heat produced must be proportionate to the amount of work done.

The vapor of water or steam must be raised from its initial temperature of 212 deg. Fahr. to nearly 3000 deg. Fahr. before disassociation takes place.

Water being a chemical compound, heat is required to overcome the mutual affinity of the hydrogen and oxygen and hence although over 60,000 heat units of the British engineering system are generated by the combustion of one pound of hydrogen to water, yet the same amount of heat is required to overcome the affinity of the component elements and hence no thermal advantage is gained.

Even supposing such were not the case, it must be remembered that all of the liberated hydrogen does not combine with oxygen to form water, but since so many other active chemical elements are present at so high a temperature part of this element (hydrogen) is combined into hydro-carbons such as methane, etc.,

while part combines with nitrogen to form ammonium compounds.

In the case of melting with carbon in an air-blast, two simple elements are brought together and combined, the resulting heat being used in melting the charge of iron. On consideration, therefore, it hardly seems possible that the figures given could have been used for any other purpose than to create a false impression in favor of this process.

Such methods of advertising are too contemptible and mean to spend time reviewing.

In speaking of the possible complete oxidization of all of the disassociated hydrogen to water it may be of interest to know that even with carbon alone it is but partly oxidized to anhydrous carbonic oxide and part passes out of the stock as hydro-carbon gas.

This is still further evidence of the invalidity of the claims cited since with carbon no disassociation takes place and therefore no heat is rendered latent from this cause.

Another quotation contains the paragraph: "Another reason assigned for use of an inferior grade of fuel is, that the impurities contained in such inferior coke or coal are burned out by the intense hydrogen flame, so that they do not enter into the iron to injure it."

Just how hydrogen is going to eliminate sulphur and phosphorus is somewhat deeper than Bresilius or Blair ever investigated the subject. Such an assertion is ridiculous since although the presence of strong reducing agents may affect the physical structure of the metal they will not in the presence of a strong oxygen reaction, such as is ever present in a cupola, decidedly change its composition as concerns these two metalloids. Even at the high temperature of the open hearth furnace, the elimination takes place only after some time and then only through the intervention of the basic slag, which is wholly wanting in the cupola.

The same reasoning also applies to another claim that reads thus: "The hydrogen flame and intense heat produced by it, and

the effect of the liberated oxygen destroy the impurities contained in the lower grade of iron, so that the iron is left comparatively pure after being melted in and by these gases. As a result the foundryman may use a lower grade of iron than would otherwise be adapted to his purpose."

The fact of the matter is that the whole process seems to be interpreted amiss by its promulgators. There can be no doubt that the metal attains a much higher heat when this process is used, and since the solubility of carbon in iron varies as the temperature of the solvent, a larger percentage of carbon is carried in iron melted by this process; and hence the reason why lower grades of metal can be used. This main feature seems to be totally unknown to the Doherty Process Company, or to the inventor himself, and is the one great point upon which the utility of the scheme depends.

It seems strange that if Mr. Doherty is the inventor of this process, as he claims to be, that he should be so absolutely ignorant of the reactions which take place in its operation.

We now come to another claim that reads as follows: "Again, in melting iron there is ordinarily great loss, and particularly so in the use of scrap, from the fact that rust (oxide of iron) passes off in the slag. Iron rust is, practically, iron going back to the ore state, and the heat of the ordinary cupola cannot resmelt the oxide of iron. By the aid of the hydrogen flame and the liberated oxygen, this iron rust is resmelted, converting it into pure iron, so that the loss is reduced to a minimum. Foundrymen often have detected a loss of 30 per cent in melting rusty scrap iron, whereas by the Doherty Process it is claimed that the loss is reduced to less than 2 per cent." After reading the last quotation it would be hard to believe that the author of it possessed the powers of reason or even was able to imagine that a foundry was operated for any other purpose than to lose money. In a shop melting 400 tons per day the loss per day would be equal to 120 tons or at $10 per ton, $1,200 per day. If these conditions held in practice, surely foundrymen would be in business for glory only.

If an analysis of cupola slag has ever been made that showed more than 4 per cent of iron—the author does not know of it. On the other hand, he has made hundreds of such analyses that showed no more than 2.5 per cent of iron. However, there is no doubt that a reduction of iron oxide does take place under this process, and slag taken while this method is in operation should not show more than 1.5 per cent of iron.

It certainly is to be regretted that so excellent a process ever fell into the management of so inexperienced and irresponsible men. By making such absurd claims its promulgators are greatly injuring its chances among capitalists and business men rather than doing it any good.

Another paragraph reads thus: "It is a laudable ambition on the part of every foundryman to be able to produce smooth and perfect castings, no matter for what purpose they are intended; but not all are successful; neither is it an easy matter to obtain perfect castings where delicate patterns are to be wrought, without using a high grade of iron.

"By the use of the hydrogen flame the iron is rendered very hot and homogeneous, so that all castings come out in perfect condition, being very smooth and even. Those who have used this process state that it is exceedingly rare to lose a casting, no matter how ponderous or how delicate it may be."

It must be confessed that it is very difficult for a practical foundryman to see how the injection of steam into the air blast can produce a homogeneous metal. It is also hard for the uninitiated to understand just how the use of this process could make a good casting in a bad mold, but such is what we are told.

In conclusion, let us consider one other claim, which reads as follows: "Where machine work is required, it seems to be the usual practice to make the mixtures of the softest irons possible in order to reduce the expense of working in the machine shop. This necessitates the use of high grade irons, or lower grades which may give softness, but which are apt to render the iron weak. Even then a 'scale' or hard surface is formed, which it is difficult to work through. As the hydrogen flame burns out the

sulphur and other impurities contained in the iron, the casting is rendered very soft and easily worked, even though a portion of the graphite carbon has been converted into combined carbon, thus rendering the casting much stronger than it otherwise would have been.

The increased tensile strength of the castings produced and their semi-malleability is one of the most remarkable features incident to Mr. Doherty's process of melting. In England, where iron and coke are inferior to the grades used in this country, the tensile strength has been increased as high as 38 per cent. In this country it is a common thing to be able to increase the tensile strength 25 per cent, although the castings are, as above stated, always soft owing to the fact that the impurities have been burned away. Ordinary stove plates can be punched cold with inch holes not more than one-eighth inch apart, and an ordinary test bar may be put in a vise and upset cold to an extent of 25 per cent of its diameter. These latter tests have been made repeatedly on iron produced from 70 per cent common scrap and 30 per cent No. 2 and 3 foundry pig."

Metallurgical science should feel most deeply indebted to Mr. Arnold for the facts which he has given to the world, and most of all for telling poor benighted foundrymen that the greater the iron constituent of a metal, the softer it will be.

I believe, however, that most foundrymen would advise him to spend his spare time somewhere in the neighborhood of a foundry before he again startles the foundry world with another choice lot of his foundry-fiction and humor.

T. Bowers, also referring to the Doherty Process, says:

If any of our foundries are experiencing difficulty in melting during dry weather, they are certainly in such a semi-conscious condition as not to be able to realize their predicament. Day after day, rain or shine, they are melting iron with the same amount of fuel, and the foreman who should have the audacity to blame the weather for a bull heat would likely find his employer planting the impression of his boot on the former's anatomy. It would be quite a joke on us if we should charge up a cupola

during a thunderstorm, according to a wet weather formula, and by the time we got ready to put on the wind, find the clouds blow away and leaving us without enough atmospheric assistance to get the iron out of the cupola.

Mr. N. T. Arnold, in writing of the Doherty Process in last month's Foundry, forgets that we have in all mechanical operations a factor of safety. This is present in the melting of iron also, and the man who is running his cupola at such a close ratio of fuel as to be affected by atmospheric changes, is operating without a factor of safety. At the end of the year it will have cost him more to make his savings than they are worth. I have never seen any difference in melting whether a wet sheet was placed in close proximity to the fan or not; in fact, it seems to me as if the fan would derive its supply of air from any other source except through the sheet, for the air would certainly not flow through the wet sheet, when it is so much easier for it to go around. However, I know of several metallurgical processes that are not operating at the present time because a wet blanket was placed on them.

Coming back to water, its elements, hydrogen and oxygen, and its decomposition into its component gases, I want to ask Mr. Arnold a very plain question: If he can perceptibly increase the heat units of fuel by the injection of steam in the cupola, what is to hinder him from burning steam under our locomotives and fires of all descriptions? It seems to me that, as far as fuel saving is concerned, he has started in the narrowest field possible, the proportion of fuel used in the cupola to that consumed at large being very small. If steam will save fuel in one fire it should do the same in another, and I believe the railroad managers are as anxious to decrease their fuel bills as ever was a foundryman.

Is it not a fact that as many heat units are required to convert steam into hydrogen gas, as this gas contains? From Mr. Arnold's article one would suppose that whatever steam was injected could have its elements separated and be changed into a combustible material without any expenditure of energy. He

would ask us to believe that the hydrogen gas burned in the cupola was a clear gain. We cannot produce something for nothing, and I should like Mr. Arnold to tell us of the cost of the hydrogen gas furnished to the cupola by Mr. Doherty's arrangement. As we know approximately the cost of a certain number of heat units in coke it would be interesting to have him give us the cost of a certain number of heat units of hydrogen gas, as made by the above-named system.

Before we can be expected to confidently accept the statement that "a saving of fuel is effected" because "the hydrogen flame is" hotter than the carbon flame, it will be necessary for us to know its cost. There can be no saving unless the number of heat units contained in the hydrogen gas cost less than an equal number of heat units contained in coke. Melting of iron is accomplished at the expense of so many heat units, and I fail to see whereby an inferior grade of fuel having a less number of heat units can be adopted economically.

Whether Mr. Arnold is a foundryman or not, one thing is apparent, he does not understand the peculiarities of cast iron, whereby we are entitled to adapt it to many different requirements. He claims that with the Doherty process a cheaper grade of iron may be used because "the hydrogen flame and the effect of the liberated oxygen destroy its impurities." If the intense heat of the hydrogen flame will destroy the sulphur contents of the iron, will it not also destroy the silicon? Mr. Arnold labors under the misapprehension that pure iron is wanted, something a little consideration on his part to the uses to which cast iron is put, will dispel. What he terms the lower grades of iron, are already the purest, being deficient in silicon, carbon and other elements.

We are told that there is ordinarily great loss in melting, from the fact that rust or oxide of iron passes off in the slag, often as much as 30 per cent. How would Mr. Arnold proceed to figure up a heat if he expected to lose up to that amount? I should hate to have him figure up a heat in my shop on that principle. I could guess closer and have less iron left.

Again, we are furnished the cheerful information that "the hydrogen flame and liberated oxygen will convert the rust into pure iron." I don't believe Mr. Arnold intends to pose before the foundrymen of America as a humorist, but this statement is enough to cause a billygoat to smile. Just to convince Mr. Arnold that he is not a transmutor of metals, nor a real conjuror, I would ask him to take a ton of rust, nothing else in the shape of iron, and charge up his cupola. Then let him turn on the intense heat of the hydrogen flame and all the powers of the liberated oxygen, and then I want him to tell me how many pounds of iron he taps out.

Surely Mr. Arnold does not mean to claim that he can convert steam into iron, and yet that is what his words say. Oxide of iron is not iron, and if steam converts it into iron it must supply the missing elements. When Mr. Arnold says that all castings made by the Doherty process come out smooth, he asks us to believe that iron melted by that method is smoother than if melted by any other method. He asks us to believe that the Doherty process flattens out the molecules, so to speak, and makes up for poor molding materials. I have been knocking myself on the head for half an hour trying to see how the hydrogen flame could in any manner make a smooth casting in a rough mold and I give it up. It also appears as if the Doherty process of melting overcomes core blowing, for Mr. Arnold states that a casting is seldom lost, no matter how intricate it is.

Punching stove plate and twisting test bars is an old trick, and if Mr. Arnold will look through The Foundry of a couple of years ago, he will find several examples of that art. I should like to have Mr. Arnold furnish me with the names of half a dozen reliable founders in the United States who are using the Doherty process and ready to testify to its merit. As a foundryman I am willing to convince myself of anything not conflicting with common sense, but I have yet to see the first instance where something was obtained for nothing.

Speaking of the purifying effects of the hydrogen flame reminds me that blast furnaces ought to be willing to adopt it, and

then the foundries would have less cause to complain. Why not make the iron right in the first place, Mr. Arnold, instead of leaving the task of purifying it to the foundry? I believe the Doherty process starts at the wrong end. If it is economy to burn steam in the cupola, it must also be so in other places. When the time comes that I can see a locomotive generate steam with steam, when hydrogen gas is demonstrated to be a cheaper fuel for cupolas than coke, then I will be ready to adopt it. Mr. Arnold might tell us the cost of melting iron by the Doherty process, and then we could form some opinion of its economy. His paper contains nothing but a few generalities and a whole lot of claims, without any proof to substantiate them.

Let him offer the scientific explanation of the phenomenon, which others failed to secure. Let us have the analysis of iron so that we may judge of its properties. There is nothing to be gained by keeping such things in the dark, and Mr. Arnold will find that a ready explanation of the Doherty process will offer the speediest way of securing its introduction.

In "Cast Iron Notes," W. J. Keep writes of "A Shop Test for Hardness," originally suggested by Charles A. Bauer, and now being perfected by Mr. Keep, of which he says:

There have been various attempts at devising a test for hardness. Professor Thomas Turner's apparatus measures the load placed on a diamond necessary to cause it to cut a polished surface. It takes considerable practice to be able to tell when the diamond begins to cut, and different observers are not likely to see alike. For chilled surfaces, or for hardened steel, this is probably the best test yet devised. However, the skill required prevents its being used as a shop test. Gray iron, or iron that can be cut, is more generally used than the irons which cannot be cut; in fact, a machinist will judge of hardness by the ease with which a file or tool will take hold. The other day I saw, at the Detroit Emery Wheel Works, a test for the cutting quality of an emery wheel. A rest was provided which moved without friction and which was pulled towards the wheel by a cord passing over a pulley, to which was hung a certain weight. A bar of

steel of a given size was fastened to the rest. The emery wheel was run at the most desirable speed and the length of bar cut away in one minute denoted the cutting quality of the wheel. If a test bar is held against such a wheel, the length that is cut away in one minute is a test of hardness.

For a test to be of any value, all conditions must at all times remain the same.

For it to be a shop test the result must be purely mechanical and not depend upon the judgment of any one.

Mr. Bauer, who is the general manager of the great harvester works of Warder, Bushnell & Glessner Company, of Springfield, Ohio, has spent much time in determining the most economical speed at which drills of different sizes should be run, and the best angles for the cutting edges. If the temper and quality of steel in the drill is always the same, and a definite size of drill is used, and a definite pressure is put upon it, Mr. Bauer thought that the number of revolutions of the drill, required to penetrate a casting to a given distance, would be a good shop test for hardness, and probably the best test that could be devised.

When I first saw a description of Mr. Bauer's device in the American Machinist, April 1, I proposed that I should make a machine for general use, and this being agreeable to him, I set about it. The machine will soon be completed. It will consist of a horizontal drilling device, with a guide to insure the drill entering the test bar exactly midway between its sides. This horizontal position will insure the free exit of chips. The drill will be driven by a clutch pulley attached to its spindle. Working in a small pinion on the spindle is a cut gear making one revolution for every ten of the spindle. The axis of this slow gear is a long screw, 20 threads to the inch. Sliding on suitable guides, and moved by this screw, is a table holding a record paper. At right angles across this table a pencil is moved three times as far as the drill enters the test bar.

To drill through a 1-2 inch square test bar at the same rate that Mr. Bauer's machine drilled soft cast iron, would take about 200 revolutions. For 200 revolutions the screw will move the paper lengthways one inch, and the pencil will move at right

angles 1½ inches while drilling ½ inch deep. The diagram will thus be the diagonal between the starting and ending point. The shape of the diagram will show the hardness of the skin of the test bar, and increase in softness towards the center. If any spongy spot is found, the diagram will show it.

By constructing a series of diagrams on transparent celluloid and numbering them, the relative hardness of skin and center can be determined, by laying the transparency over the record and finding to which standard diagram it more nearly corresponds. Steel hardened so that a drill cannot cut it would give a straight longitudinal line for a diagram. If the drill were allowed to move forward with nothing in front of it, the diagram would be a straight lateral line at right angles to the diagram of a perfectly hard material. Diagrams of all materials must lie at different angles between these extremes, and any variation of any part of the diagram from a straight line will indicate a variation of hardness in different parts of the test bar. As each 1-20th of an inch on the diagram measures ten revolutions of the drill, and the large wheel being graduated to 1-10 of a revolution, the exact point when the lip of the drill enters or leaves the surface can be determined. The action of the machine is wholly automatic. When the drill rests on the test bar with 160 pounds pressure, by touching a lever all parts move together, and when the drill leaves the other side of the test bar the pencil records the instant, and the apparatus stops without an extra fraction of a revolution.

It is thus seen that the operation is wholly mechanical and that any boy can locate the test bar and start the machine. When the diagram is complete the machine stops, and when the foreman comes along he can subtract the former reading on the large gear from the present reading and measure the 20th inch length, and he has the revolutions to 1-10 of a revolution. For convenience an ordinary revolution counter will be attached to the long screw to read to 10,000 revolutions.

On the forward end of the spindle will be placed a corundum wheel and a grinding device, by which the drill will always be

ground exactly the same at all times. The Morse Twist drill Co. agree to make drills for this apparatus that will not vary in quality and the grinding wheels will be of uniform composition.

When the apparatus is completed a hole will be put through each of the test bars which were made by the American Society of Mechanical Engineers in 1894. As this hole will be alongside the hole from which drillings were taken for analysis, and as the bars were ½, 1, 1x2, 3 and 4 inches square, and as there were 19 different mixtures of iron, the records will be very valuable. It is expected that before spring a paper describing these tests will be prepared, and that Mr. Bauer will also prepare a paper describing all of his experiments, by which he arrived at the adoption of a drill test for hardness.

Mr. Bauer deserves all the credit for the adoption of this test for hardness. It will be a true shop test and at the same time fitted for the most accurate work.

Following Mr. Keep's article is an illustrated description of the apparatus as originally used by Mr. Bauer, who says:

The frequent complaints from our machine shops in reference to the hardness of cast iron has made it desirous to add to our daily physical tests some simple, practical method for determining the hardness of cast iron. All known methods were found to be too complicated or impractical for daily use, and we concluded that as a drill revolving at a reasonably uniform rate of revolutions under a constant pressure would drill a given depth with a certain number of revolutions, it would require more or less revolutions if the metal is harder or softer; we have, therefore, adopted the following method, which is giving us all the information that could be desired.

An ordinary drill press is equipped as follows: On the pinion shaft, which raises and lowers the spindle, is attached a disc 12″ in diameter, around the periphery of which is placed a light plumber's chain, on the end of which by means of a wire is suspended a weight which maintains a constant pressure on the drill. We have placed a small platform scale on the drill table, then placed the test piece to be drilled on this scale, and found the

actual pressure on the drill to be 160 pounds while making a test. A 3-8″ flat drill is placed in the chuck after being carefully ground in the tool room by aid of a fixture to a known thickness, angle of lip, etc.; though this uniformity of grinding is not depended upon solely for the accuracy of the results. The drill spindle has a revolution counter, and by means of magnets and an armature is controlled by the position of the drill in relation to the table. All adjustments are made so that the revolution counter is thrown into gear after the point of the drill is entirely embedded under the surface of the test piece, and out of gear when the spindle has descended from this point exactly 1-2″. When a test is to be made, the test bar is placed on the table and the drill is brought down upon its surface; the feed lever is then unlatched and everything is as shown; the drill is now rotated about 250 revolutions per minute and the hole drilled. The revolution counter is electrically thrown into gear after the drill point is buried beneath the surface, and out of gear when the 1-2″ from this point has been drilled. The reading of the revolution counter now gives us the exact number of revolutions required to drill the 1-2″, and this we term the degree of hardness. The more revolutions required to drill this 1-2″, the harder is the casting, and a slight degree of hardness is easily detected.

As to the reliability of the test: We have drilled ten holes into the same bar and received results varying from 166 to 170 revolutions, the average being 168.2; the variation, therefore, being less than 1½ per cent. In order to assure ourselves that the condition of the drill had not changed, a test piece previously drilled, and for which 173 degrees of hardness was obtained, was redrilled with exactly the same result. The condition of the drill is obtained each day by drilling a test piece of previously determined hardness, and then comparing the result with the previous one; the increase in revolutions represents any change which may have taken place, and from this a constant test is obtained, and the pieces tested that day reduced to the standard. When we obtain a constant of 1.2, the drill is resharpened and its new constant established as above. We make not less than two tests each day,

and found it necessary to resharpen the drill but three times during the past year.

In writing of "False Melting Ratios," W. F. Prince advances the following:

I am not jealous of any man that can produce his metal cheaply, and if he has a way of melting 1 to 10 or 12, he is doing very fine, but if he is not he will do the foremen of the country a great favor by telling just what he is doing and not what he thinks he can do. He will also prove himself a public benefactor by giving a clear detail of the size of his heats, class of work and distance to carry iron and what he has to handle his iron with.

It has been my experience, and I think that of my fellow foremen, to have the owners come to me about once a month wanting to know why I cannot do better than I am doing. They will say: We see by different papers that so and so are melting 1 to 10 or 12 and you are only melting 1 to 8½ or 9. I had an experience once with a company I was foreman for, which probably all foremen have had to go through. The superintendent came to me one day and said he wanted to have a serious talk with me about melting. That he knew for a fact of a foundry foreman who was melting 1 to 14, and thought it time we did something to better our melting. I told him I did not believe it, but he had his information from such good authority that he felt sure it must be right and would not listen to anything said against his statement. We had a shop 250 feet long, 110 feet wide, with a cupola in one end of it and had no way of delivering the iron throughout the shop except by handling it from one crane to another. Our work was light and required hot iron and melting at 1 to 8½, the iron was none too hot by the time we could get it to the mold. We were melting pig iron and heavy scrap.

I wanted to do all I could and so we started to do better. We increased the speed of the blower and cut down the usual amount of coke; got dull iron and lost castings. The iron appeared to come hot enough from the cupola, but did not have life enough to stand the handling down the shop. The ladles bunged up and our intended economy resulted in a regular mess, and the opin-

ion that I did not understand melting. We weighed every pound of coke and iron, and did not measure it by a box, supposed to hold so much. Ours was actual weight. Later I made it my business to find out some further particulars about the shop which had furnished the record we tried to reach. What was my surprise to find that in charging they called a certain number of pieces of pig iron a ton, and the coke was measured out by a box supposed to hold 400 pounds level full, but a man could easy put on a hundred pounds more if he felt so inclined.

I know iron can be melted 1 to 10 if it can be poured immediately without carrying it too far, but take a jobbing foundry, where different castings are turned out each day, and where there is always going to be some iron left, in pouring heavy pieces, which must be taken back to the cupola, and the case is different. Here some of the iron must be hot enough to run stove plate, and some has to be chilled down for heavy chunks, and I consider, taking it altogether, that 1 to 9 is good melting. These high reports have done more towards creating dissatisfaction, and in many cases resulted in the discharge of competent foremen, than any other thing in the foundry business. I believe the best thing that can be done to counteract this evil influence is to look up all these high records, and find out the exact circumstances under which they are made. It might pay us to hire some of these makers of abnormal records to teach us how it is done, if they can prove their claims, but we do not want any guessing to count in place of actual figures. We want to know only what a man does and not what he considers possible. When we want examples of cupola practice, we want cupola practice and not cupola theories.

V. Wolfe takes up "Cleanliness in the Foundry," in the course of which he says:

I have been in foundries where a lady could walk down the gangway and up the aisles between the floors without soiling the hem of her dress. I have been in others where she would be compelled to raise her skirts to an indecent height for fear of having her garments come in contact with the hundred and one

obstructions that were piled up in confusion everywhere. It is just a matter of pride and taste on the part of the foreman and men which kind of a house they want to keep, and each individual molder can do his part toward making the choice.

No doubt there are some shops where the proprietors are too niggardly in providing help for the foundry to admit of cleanliness and order, but such shops are few. If every foreman were to insist that the molder should brush off the top of his flasks, that he should keep strictly to the line of his own floor, that the space between his floor and his mate's should be kept free from scrap and rubbish, that all flasks, clamps, patterns, etc., which he was not using should be taken away, and were he to insist that a place be provided to store all articles not in immediate use, were he to see that the gangways were swept at least once a day, and all the shelves and benches brushed off at the end of the day's work, then it could not be charged as it is now that in most all factories the foundry is the most slovenly department in the whole concern.

IRON TRADE REVIEW.

A. E. Outerbridge, Jr., in discussing "Sources of Error in Testing Cast Iron," says:

My experience has taught me that published records of tests of cast iron are of no value, unless you know the conditions under which the castings were made. Let us suppose that two bars are cast in one mold from one ladle of good strong foundry iron, for tensile tests. One bar may be 1 inch diameter, the other 4 inches diameter. Let us suppose further that they are turned, on a lathe, to $\frac{7}{8}$-inch diameter, 10 inches between shoulders, and pulled on a testing machine. If the bar which was cast 1 inch diameter shows a tensile strength equivalent to 30,000 pounds to the square inch, I would not expect (from actual experience) the tensile strength of the companion test bar, made in the same mold, cast from the same runner and same ladle of iron, turned to the same size and pulled on the same machine, would show tensile strength much over 18,000 pounds to the square inch. In fact, it would probably be under, rather than over, that amount.

Again, surprising thought this may be to many, it is not a fixed law, for the ratio varies according to the character of the iron. The rate of cooling is also such an important element that it is entitled to be considered a function of the physical properties of cast iron. The rapid cooling of the surface metal and slow cooling of the center of a test bar (unless it is quite small) and of castings, causes strains which are entirely distinct from "shrinkage" of the metal as in steel, or from the normal shrinkage of the cast iron. Failure to understand fully these laws is responsible for many remarkable errors of observation which have been recorded.

A minute flaw in a test bar will invariably weaken it greatly, as compared with a companion piece which is free from such defects. I have found, however, that a test bar may be riddled with holes drilled through the section and instead of being weakened, as we might expect, the bars are often strengthened thereby. With 1-inch bars rows of ⅜-inch holes may be pierced by drilling and in very many cases the bars will break through solid metal at one side of a hole. I attribute the gain in strength to the relieving of internal molecular strains in the castings by drilling the holes. This is a test which may be very easily repeated by any one. Of course it must be understood that in casting stove plates, or other thin sections, and small bars—especially from iron high in silicon—these conditions are modified, the cooling strains being almost nil.

IRON MOLDERS' JOURNAL.

A contributor has the following to say in regard to malleable iron:

Of all the metals taken from mother earth none are so plentifully abundant as iron; and of all the metals used in this big, busy, industrial world of ours none are used to the same extent. Its use began before history was thought of and has increased till, to-day, no living tongue could enumerate its multitude of functions, nor pen portray the astonishment of that first artificer in iron—Tubal Cain—could he come back from the dead past and look on the living present with its ponderous machinery and wonderful mechanisms made possible through the agency of iron.

Wrought iron, cast iron and steel have been harnessed to man's service from time immemorial, but useful as this trio have proven themselves to be, there was still one missing link in the iron chain. That link was found and the grand chain completed when malleable cast iron was discovered, and its use inaugurated in the industrial world. One authority, in speaking of malleable iron, says: "Some means of arriving at the same result appear to have been known to the iron-workers in the middle ages, as there are numerous examples of malleable castings to be found in old buildings." All seem to agree, however, that the credit of introducing it in modern times is due to Samuel Lucas, of Sheffield, Eng., who, in 1804, obtained a patent "for a method of separating the impurities from crude or cast iron without fusing or melting it, and of rendering the same malleable and proper for several purposes for which forged or rolled iron is now used; and also by the same method of improving articles manufactured of cast iron, and thereby rendering cast or crude iron applicable to a variety of new and useful purposes." It is only within the last quarter of a century, however, that it has developed to its present position of importance in the iron industry. When first it came into use it was confined to small, light work; but year after year its scope has widened till to-day it is taking the place of grey iron in work that formerly it was thought impossible to make in malleable. Its usurping qualities have not been confined in their operation to the field of cast iron alone, for it has also invaded the domain of wrought iron and steel; so much has this been the case, that this intermediary between cast and wrought iron has become indispensable in the manufacturing world to-day.

The first question that might be asked is what pig iron is used to make malleable. Originally only charcoal irons were used, but later experiments have demonstrated the availability of Bessemer pig iron. An authority on these matters informs me that the iron best adapted for malleable should be low in all metalloids except carbon; silicon being about 1.25 per cent, which would cause about one-third of the carbon to be in the combined form.

The melting of malleable is done both in the cupola and the reverberatory furnace. For small work, where a uniform, su-

perior metal is not absolutely necessary, the cupola can be used to advantage, but it is impossible to turn out a uniform grade of metal from it. The reverberatory furnace is, however, best adapted for all kinds of work, hence the great bulk of malleable iron is run from these furnaces. The iron does not come in direct contact with the fuel as it does in the cupola, and is therefore less liable to be affected by it. The fuel used is usually a good, close bituminous coal, although some types of furnaces are adapted for the use of oil or natural gas.

A charge of five tons is usually melted in about 3½ hours with good fuel. After the iron becomes fluid it is skimmed through a slag-hole provided for that purpose in the side, and, just before tapping out, this operation is repeated. It now becomes necessary to test the iron. This is done by dipping out a little iron and pouring it into a round bar about 1½ inches thick and 6 inches long. This is carefully cooled in water and broken; if the fracture shows clear white and free from little black specks it is said to be "high" enough and, therefore, ready for pouring. If the black specks or a dark color show in the fracture it must be given further time in the furnace. When the test shows that the iron is right no time is lost in tapping it out and pouring it, for when it reaches the desired point it has a decided tendency to go back. When tapped out at both sides of the furnace for "shank" and hand ladles, a five-ton heat is usually run out in about twenty minutes. To do this the molders must get a "move on," and, if perspiring faces are any indication, they do. As soon as the tap is run out the bungs are lifted off and the charge for the next heat is put in. This is also lively work. The charge is piled ready beside the furnace and is passed from hand to hand by a row of men. First the sprues and scrap are dumped in, then follows the pig iron and inside of fifteen minutes the charge is in, the bungs replaced, and the flames roaring over and through the iron. It was at one time thought to be impossible to secure a good quality of cast malleable iron if old annealed scrap iron were used in the charge, but that day is past and the large piles of old scrap that lay around the country are being rapidly converted into good malleable castings.

When the iron is poured it is at a white heat—the high temperature being necessary to hold the carbon in combined form, and, as it falls into the ladle and is conveyed to the mold, bright scintillating sparks are given off. When the castings are taken out of the sand they are extremely brittle and show a clear white fracture. They are then cleaned either by tumbling in a mill or by pickling in diluted sulphuric acid and are ready for the annealing pots. In these pots the castings are packed with fine iron turnings that have been sprinkled with sal ammoniac to form an oxide of iron. The packing must be carefully done, for not only does it assist in preventing fusion, but it prevents the castings from being twisted out of their original shape when they become plastic under the intense heat to which they are subjected. The pots are then placed in the annealing oven which is hermetically sealed and the fires kept going night and day for a period varying according to the weight of the castings to be annealed. The pots are kept at a cherry-red heat. Five days is about the average time given, then the ovens are allowed to cool off gradually and the pots taken out and the castings removed. To remove the bright blue surface discoloration the castings are again put in the tumbling barrels. After annealing, the castings, that were originally as brittle as glass, will be found to be as pliable and tough as wrought iron, and there are instances where it has stood welding; thus clearly demonstrating that it has left the field of cast iron by the annealing process, which is really the art of changing the combined carbon in the castings back to the graphite state, but distributed throughout the iron in atomic particles, rather than in the form of crystals, as it is found in grey iron.

And now a word about the molding for cast malleable. The unforeseen largely enters into any class of molding, but more especially so can this be said in this case; for while this iron has all of the explainable and unexplainable freaks of grey iron, it also has a "cussedness" that is peculiarly its own, which oftimes sets at defiance all established precedents. Its liability to crack, to shrink, to honeycomb, to blubber, to misrun, to coldshut, or blow, keeps the molder guessing or experimenting right along.

No matter how successful he may have been on a job once, the next time he gets it all his past experience may not avail, but entirely different methods have to be pursued. While the ramming and pouring might be the same the results are not; it will, perhaps, crack or shrink in some unaccountable manner, that will necessitate a complete change of tactics. For some reason that the writer cannot explain, a mold prepared for malleable iron will not stand the hard ramming that is required for grey iron without blowing. While the molten iron, because of its intense heat and consequent fluidity is of a most searching character, it does not seem to exercise as great a strain upon the mold and a perfect casting can be turned out from a mold rammed so soft that had grey iron been poured into it, it would have produced a most unsightly object.

One of the most essential things in preparing a mold is to place chills to prevent cracking, drawing or shrinking. Some years ago this feature did not so largely enter into the molder's art, but to-day competition has become so keen that the price paid for the castings does not warrant the use of the superior grades of iron that formerly obtained. The molder, then, is required to counteract natural results by artificial methods, and, to the uninitiated, the number of chills used in the molding of some pieces would be indeed astonishing, as would also the heads and shrinkers used on work that has heavy parts. No specific rule can be laid down for the placing of chills and shrinkers, the molder finding out by actual experiment, guided of course by past experience.

In pouring work having heads or risers you stop pouring in the runner-gate as soon as the iron appears in the riser, and flow the iron back through the riser, so as to keep the iron hot and feed the casting in the desired spot as long as possible. To prevent the chills from burning to the casting various methods are adopted, such as facing them with shellac or oil and parting sand; but where the work is heavy there is nothing superior to a good coat of wash made from fire-clay, applied when the chills are warm.

The sand and iron used are, of course, the essential factors in determining the appearances of the castings. The sand must be

selected according to the character of the work to be made—the fine sand necessary for the small work would be entirely out of place for draw-bars or other heavy work. While in some shops it is customary to use facing-sand and plumbago on fairly light work, the fact remains that in one of the largest malleable iron foundries in the country, and one which has a reputation for turning out castings that are second to none, facing-sand is only used at the gates or where the continual flow of iron would cause "cutting," except on the heaviest class of work; while plumbago or blacking is not used at all. This has demonstrated to my satisfaction that good sand and good iron obviate the necessity of extra precaution and expense in order to turn out castings with a clean, smooth skin.

Although malleable iron, under the most favorable conditions, might fairly be classed as "tricky," it is a well-known fact that its trickiness has increased since old annealed scrap has found its way into the charge. While this innovation has undoubtedly cheapened the product, it has made the work of the molder more uncertain, for its influence on the fluid iron seems to render it more liable to give trouble from blowing, honeycombing or cutting the mold; and to overcome these evil developments the resources of the molder are taxed to their fullest extent. With this must also be considered the greater variety of work and its greater size and weight than was made a few years ago. Its progress in this respect is simply astonishing. As its usefulness and serviceability become better known and understood, new fields are ever being opened up for it, and it seems as if malleable cast iron were destined to play a still more important part in the iron industry of the future.

In replying to former statements made in the Journal by R. D. Moore in relation to the pressure of fluid iron, Henry Hanson says:

Mr. Moore's reference to the effect of a snowball in the muzzle of a gun is a little out of place, when he compares it to the effect of pouring a mold without risers. The powder forms an expansive gas, which, if confined, reaches such a high pressure

as to burst the gun. Fluid iron is not a gas and cannot be considered in the same category, it is a different material with different characteristics, and while all moving bodies exert a force, according to their weight and speed, on which more or less theory can be expended, the speed at which melted iron travels perpendicularly, in pouring a casting with a large lifting surface, is so very small as to cause but little apprehension from this source.

Briefly stated, fluids seek their own level, and if a pouring gate is 12 inches high and the riser 6, the tendency of the iron is to reach above the riser owing to the elevated position of the supply. Just as the water of a fountain tries to reach the same elevation as the source from which it comes, so does melted iron try to reach the same height as the base from which it issues, viz., the lip of the ladle.

I believe Mr. Moore and myself belong to the same part of the trade—the machinery branch, and as we increase our dimensions in pride of what we represent and contemplate what the world owes us, we believe we are about "the only pebbles on the beach." There is the stove molder working like blazes, and what is our opinion of him? No brains, just honest hard work, that is all. It happens that the stove molder is working on the very kind of castings that Mr. Moore is wont to use as a basis for figuring the pressure of iron. He works on all kinds of castings, having a great lifting surface, and I want to ask Mr. Moore what he believes the average stove molder would think of the suggestion to put three or four risers on each stove casting? The stove molder has a very small limit for weight, but he comes inside of it. He is required to pour his castings hot and fast, and if there ever was a place where the application of risers would relieve pressure, it is here.

How does the stove molder make his castings conform in weight? Not a riser even! Pours the metal right into the mold too, and not through a side gate. Maybe it takes several molders to pour a casting and yet it is true to weight. Suppose Mr. Moore had four machinery molders pour a plate without a riser on it, what would he expect? What would he say if it came out right in weight? This is what the stove molder does every day.

How do they do it? How do they keep their castings from straining without a riser? Simple enough, when you know how. They stop pouring when the mold is full. Observe the machinery molder pouring a plate. He has got a cope at least six inches deep and maybe a runner box adding four or more inches to the height of his runner. Instead of stopping pouring when the mold is full, and there is an inch or two of metal in the gate, he is not satisfied until he sees the riser or runner flowing over. "Touch her up," says the foreman, and in goes fifteen or twenty pounds of iron, see-sawing from riser to runner. As the metal sinks slowly down, due to the strain put on the mold, some one says, "Give her a little more." What kind of castings would the stove molder have if he kept on pouring till his gates were full? What would his work look like if he practiced "touching up?"

Here is the machinery molder, in the majority of cases, getting out rails, binders and weights, just in order that he may have the satisfaction of "touching her up," and what is the use of it? An inch or two of head on plates and castings having a flat cope surface will make as good a casting as one a foot high, and the result will be a more perfect casting. The stove molder is the peer of the machinery molder when it comes to producing castings of even weight, and I would advise Mr. Moore and others with a strong faith in the "riser" to study the stove molder and his methods. It will be an object lesson of no mean importance. If the machinery molder has a discount placed on heavy castings, like the stove molder, he would quickly learn to account for these without blaming the absence of risers.

THE METAL WORKER.

Thomas F. Kennedy writes an article on "Mixing the Material for an Oil Match," and as this is a part of foundry practice about which but little has been said, we reproduce it in full:

Get a bottom board free from holes with an area of about six square feet, say 2x3 feet. For the purpose of measuring the material lay the frame on the bottom board, and as the sand constitutes the bulk of the material it is all that need be measured. By noting carefully the irregularities in the drag one can come

very close to the right amount, whether more or less than the frame level full. Any kind of well burned molding sand will do, but I find that the best of all is sand from castings that have been cleaned with a wire brush; no mill dust. Put this through a very fine sieve, not less than No. 12, the fine sifting being essential to the making of a durable match. If too coarse a sieve is used the edges of the match exposed to wear will soon crumble, and these matches have often been condemned for not wearing well when the fact was they were not properly made. If raw linseed oil is to be used, mix with the sand about 1 of litharge to 16 in bulk of sand. No rule as to exact proportion of oil and sand can be given, but a quart will wet from 140 to 180 cubic inches of sand, enough for a frame 10x14 to 12x15 inches 1 inch deep, or 1 of oil to from 7 to 10 of sand in bulk. The only rule I observe is to make the sand as wet with oil as possible without danger of it sticking to the pattern. This is another reason why these matches do not wear well; not enough oil is used in them. Mix the oil and sand thoroughly, as much of the wearing qualities of the match depend on it. Get an old ¼-inch riddle, as it would spoil a good one, and work the mixture through it with the hand. Never try to shake it through, as the driest part would go through first, leaving all the wet lumps till the last, and thus interfere with the mixing.

If a good quality of boiled linseed oil is used no litharge or other drier is required, unless one is in a great hurry for the match, when a little added to the oil, about 1 ounce to a quart, will cause it to dry more rapidly. Too rapid drying, however, is to be avoided. Throw a little parting sand on the drag, put on the frame, pass the straight edge along it to see that all high points clear, and see also that it is level, so that when the bottom board is nailed on it will not draw. If the flask is good and straight the frame may be leveled down to it by springing it; if not, it should be leveled up with skewers of wood or a little sand. Riddle a layer of the prepared sand into the frame now as you would on a cope, having placed the drag with the frame on alongside the bottom board on the floor so as to waste as little sand as possible. Fill the frame and give all the corners and pockets an

extra tuck with the handle of the hammer, pean around the inside of the frame as you would a cope and butt it all over lightly but often; strike it off level and throw a little sand on loosely, as on a drag. Give the bottom board a few hard rubs to get it solid, put a small nail through the board into the frame near each corner, and if match is a shallow one it will be well after giving the board a rub to give it a coat of oil. Replace without rubbing and nail it on.

Screws are nearly always used to secure the bottom board to the frame, and for a long time I used them, but find that it is unnecessary labor, as the nails answer the purpose. Roll it over now so as to bring the drag uppermost. Be very careful doing this, as the least shock may spoil it. A mold of ashes would be stable compared with an oil match at this stage. Lift off the drag and clean off all molding sand. Get a handful of the prepared sand, take a small trowel or slick, and go over all high points, such as at the toe of a stove leg or at the hinges of a door, as these are apt to be soft and must be made hard. Build a little of the sand on and press it down until hard enough. All sharp edges of the parting where the pattern will strike when being worked in and out should be examined, and if found soft treated the same. Get some small nails or brads and push them into the sand, two or three to the inch, at high points where there is a sharp edge and along all sharp edges. Rap and draw the pattern now. If you want a real nice looking job and a match that can be varnished without absorbing all the varnish, slick it all over. This is a tedious job, as it must be done with a small tool, but a molder who takes any pride in his work will not let it go out of his hands until he does it. Take an old sponge now and drop some oil on all high points and around all sharp edges with which the pattern will come in contact. If the sand does not appear to be wet enough drop oil out of the sponge all over it. Take the slick again and touch up any spot that dropping the oil may have made rough, and set your match to dry. Put it in any safe place where there is a good current of air to dry. Rats will destroy it while soft, and the least shock or anything falling on it is fatal to it. If in a hurry for the match put it on top of the boiler or core

oven, or any place where it is hot, but not hot enough to scorch wood, and it will dry in a few hours. If not in a hurry it should be left over night, and it will be dry enough to use next morning. Get some nails long enough to go nearly through the bottom board when driven through the frame, and drive them through the frame into the board about four inches apart all around. Drive from a half dozen to half a hundred, as may seem necessary, through the face of the match into the bottom board. If the match is a very deep one there is no need of driving nails through the frame into the board; drive them into the face of the match first, then turn it over and drive a few through the bottom board into the frame.

Philosophy of Matches.

This method of making matches is now widely known and practiced in a way, but the philosophy of it is but little understood. I have often asked men who could make a good one of these matches, "What makes them hard?" but not even one had the least idea or sought the reason. I remember well a man who worked in the shop where I started as an apprentice, and who made some oil matches. He kept the ingredients and mode of mixing jealously secret, and always retired to a corner of the warehouse, where no one could see him, to prepare it. Coming out he looked as mysterious and solemn as an oriental magician. If any rash apprentice asked a question about it he would shake his head ominously, as much as to say, "Better without such knowledge, my boy."

Still to any one familiar with the chemistry of oils there is no mystery about it. Writers on the chemistry of oils divide them into two great classes, volatile or essential oils and fixed or fatty; these latter are again divided into drying and non-drying. Many of the liquid fixed oils thicken on exposure to the air, and under favorable conditions dry up, leaving only a resin or gum, which is at first sticky and later plastic. The oils possessing this property are termed drying oils. Drying oils when finely divided have a tendency to inflame spontaneously, caused by a chemical action which chemists call oxidation. Raw linseed oil has great

drying qualities, which are considerably enhanced by boiling. During the latter operation driers or promoters of oxidation are added, such as red lead, manganese or litharge. The proportions and mode of mixing these are kept secret, but it is known that they act as carriers of oxygen.

The most rapidly oxidizable drying oil is boiled linseed, and in using it for a match no additional drier is required. It is not advisable to hurry the process too much, as it seems to leave the match brittle. A chemist would advise when using litharge to dissolve it in the oil, and no doubt you would get quicker action, as it is on the oil it acts, but it is more convenient to mix it with sand, and I have never had any trouble using it that way when I used raw oil. The agent that binds the atoms of sand together and makes the match hard, tough and slightly elastic is, of course, the gum contained in the oil, hence the necessity for thorough mixing and bringing every grain of sand into contact with the oil, also the necessity for sufficient oil.

It is noted elsewhere that drying oils finely divided have a tendency to inflame spontaneously, and if mixed with any inflammable substance, such as waste, under favorable conditions fire results. The conditions under which a match dries are most favorable except that the sand is non-combustible and otherwise neutral, so that the heat generated only aids in the oxidization, and drives off all moisture and volatile matter, leaving nothing but the sand and gum. When too rapid drying or oxidization takes place, too great a heat is generated, which destroys the strength of the gum and leaves the match brittle, so that it crumbles easily.

In concluding about the oil match I will add that it may be set down as an axiom, the more oil the harder, and the longer to dry. Remember to put the sand through a fine sieve. This covers all points, and any molder who reads this ought to be able to make an oil match.

THE TRADESMAN.

E. H. Putnam under the caption "Mix the Facing" says:

It ought to be unnecessary to advise a journeyman molder as to the importance of very thoroughly mixing the sea-coal facing

with the sand. But it is nevertheless a duty that either the foreman, or a thoughtful shopmate must sometimes perform.

A certain pattern of castings much used whose surface was required to be very even and smooth, showed numerous small pits, and as the general surface did not indicate any excess of strength in the facing, numerous surmises were made as to the cause. But it was ordered that no facing be used, and the result was entire absence of the pits. The per cent of sea-coal dust was none too great, but the mixing had not been thorough, and, therefore, small masses of sea coal entirely unmixed with sand lay in spots on the mold surface where, when the molten iron came in contact an excess of gas was produced and a pitted surface was the result.

By the way, old molders will remember the "cutting" and treading that all respectable molders used to do in the old days, when mixing a batch of facing. And they will also remember the smooth, clean, dark blue surface that those old molders produced on their castings. Not that it is not done quite as well today in many factories, but it certainly is not so universal as formerly.

When you had a shop full of molders and a few apprentices the apprentices speedily and thoroughly learned the trade. But where you have a shop full of 'prentices and a few molders, general results may be expected to accord with the conditions.

Mr. Putnam analyses a paper recently read by Dr. Wuest at a meeting of German Foundryman. To Dr. Wuest's assertion that "It is still the custom of founders to rate foundry iron according to its fracture. If the fracture surface possesses a coarsely crystalline, dark gray graphitic appearance, the iron will be rated as No. 1, while fine-grain iron will be rated as No. 2 or No. 3. The difference in the price originating from the different appearance of the fracture, amounts to at least one-tenth of the total value of the raw material. Yet appearances are often deceiving. The value of a pig iron does not depend upon its attractive appearance, but solely upon its chemical composition," Mr. Putnam replies: This is all quite true, though not so intelligible as a practical founder could wish. For instance, though

No. 2 iron has a fine grain as compared with No. 1, yet, considered by itself, its grain is coarse. No. 3 foundry iron has a fine grain, and it is a comparatively hard iron, but the softeners also have a fine grain, and they are much softer than No. 2, or even than the coarse grained No. 1. And sometimes misled by the appearance of the fracture, the softener is sold as No. 3. What, then, shall the foundryman do? Hire a chemist? Wait a bit. Dr. Wuest says:

"It is, therefore, to the founder's profit to use as much scrap for his mixtures as possible in order to cheapen the product. Now it is customary to base the addition of scrap, ferro-silicon, etc., upon the appearance of the fracture of the pig iron. But the appearance of the fracture is often deceptive, and the chemical composition of the same grade of pig iron may also change. Hence, this method of composing the mixture is a very unsafe one.

"It is impossible in blast furnace practice to constantly produce iron of the same nature. Its composition changes with each tapping, and even with the most careful charging an important metalloid may be present in one case in abundance, in another it may be lacking.

"If the founder makes his mixture without possessing any knowledge of the change in his pig, he may obtain in one case a casting of doubtful quality, and in another he should have added more scrap. He has thus permitted a profit to slip through his fingers. Some founders try to prevent this loss by using three, four, or more kinds of pig iron for their mixture, and in most cases they attain their purpose, but it is rather awkward to work with so many different irons."

You see what he is leading up to. If you analyze all of your pig iron you will know what goes into the mixture with the pig. It is to be presumed that even the chemist will let the scrap go without analysis. Not that he would if he could help it; but he must. But I cannot see that the general run of foundries would find any practical advantage in employing chemistry. Let us look at the matter practically for a moment. In either case, with or without a chemist, you buy a carload of pig iron and it is laid

down in your yard. If you have a chemist he analyzes it and thus you know beforehand what per cent of scrap it will carry, and proceed accordingly. Or, if it prove unfit for your use it will be rejected. If you have not a chemist you may use a small per cent of the new pig in the first heat and by studying the physical results, determine the further procedure. This may be done with safety, because an iron that looks right will not be far enough wrong to materially injure the mixture if but a small amount is included in the charge. If the latter is true, then, thus far no harm has been done, and you have secured a basis for intelligent procedure. Perhaps you don't know so much about all of the chemical constituents in this case as in the former. But why should you? The farmer who eats an Irish potato knows whether it is a satisfactory food or not, just as well in his ignorance of its chemical constituents, as the chemist who analyzed a portion before eating the remainder. The general founder is after physical results. He always wants to produce strong castings, and he wants them to be either hard or soft. If he is a good foundryman and nothing else, he knows how to get these results.

The fact is, that so seldom is the foundryman disappointed in the quality of iron that is purchased by number that in nine cases out of ten he does not even hesitate to take the chance of the hastily ordered carload of iron being what he expects it to be. Of course this is wrong, but it is true, though. And being true, it follows that he does not even employ the easy physical tests to advantage.

The iron from some furnaces is much more uniform in quality than from others, and founders like to buy of such. And this leads up to the fact that the furnace that can and will guarantee the quality of its iron will outstrip its unreliable competitors.

Soon, no doubt, most irons will be sold guaranteed as to chemical components. It is the only rational thing to do. The seller of iron is unable to deliver what is called for, but who instead sends something, nobody knows what, will soon be obliged to retire in favor of people who have something for sale and who know what that something is.

I do not wish to detract an iota from the credit that belongs to chemistry for its service to the iron industries. But I insist upon a rational and economical employment of chemistry.

I say to the furnace man: "I want a hundred tons of No. 2 foundry iron." If he answers, "I'll ship you what I think is No. 2, and if, upon a chemical analysis, you find it is something else, I'll make another guess," etc., etc., why we shall simply turn from this back number and deal with some one who knows what he has for sale.

Referring to a criticism by Dr. Moldenke Mr. Putnam says:

Dr. Moldenke seems to insist on the need and the propriety of employing the immediate aid of a chemist in each foundry. Here and here only, as I understand it, we differ. I affirm the value, nay, the practical necessity for the employment of a chemist in some foundries. I say that an exact knowledge of the chemical composition of the iron used would benefit many foundries that want that knowledge to-day. But I doubt the expediency of employing the immediate aid of the chemist in most foundries.

Dr. Moldenke's little story about the ignoramus from "the large railroad office" consenting to impose upon the defenseless purchaser by grading (?) iron without knowing how, though a point in favor of his position, is not sufficient to establish it. It was simply a very foolish and harmful thing to do, and too much of the same practice would to-day ruin the owners. Happily, we can trust to the self-interest of operators generally to prevent much of this. It is in this as in other things, the furnace that can be relied on will get the trade, other things equal.

Dr. Moldenke does not quite represent me when he says that I hold the chemist to be useless in the small foundries. A golden teakettle might not be useless in the kitchen, but it would hardly pay to use it there. The chemist could tell us the components of our iron before we use it; but I believe that in most foundries it would cost more than it would be worth.

It is no doubt true that, as Dr. Moldenke says, the chemist's work has had the effect of reducing the cost of some brands of formerly high cost iron used in special work. Most foundries, however, buy as cheap iron as they can find, without so much as

thinking of a chemist in connection with the matter.

When the proprietor says to the foreman, "Say, Peters, Koskewsky wants to sell me 200 tons of No. 2 foundry; there'll be a wagon load of it down here to-day and I want you to tell me tomorrow whether you want the lot or not." I say when this occurs Peters will know next day all that he cares to know about that iron, by the simple means of melting and casting it. This of course applies to the general foundry, and to the foreman who is adept in the physical testing of iron. It cost the proprietor not a cent for the determination, and Peters couldn't have induced him to spend a cent for chemical analysis if he had so desired. In fact, the man who foots the bills is generally rather behind Peters in this direction. Peters would sometimes be glad to have a chemical analysis—not often—say once in five years—but the boss says "No! it's costly."

Dr. Moldenke rightly says, "The fact that some people who know little about metallurgy have stumbled upon improvements in mixing iron without the aid of chemistry signifies nothing." It is true also, as he says, that "the true scientist does not ——— sneer at the founder who does not swallow whole everything said in favor of chemistry in the foundry. But where I have made the dash Dr. Moldenke had the words, "as Mr. Putnam claims." What I really said was, "It is fashionable just now to sneer," etc. This does not refer to the true scientist at all—it refers to the faddist. Nay, I will furthermore say that it does not refer to any sincere man. A sincere man may through ignorance support the faddist. The learned chemist is usually ignorant of practical founding. He sees the beauty and utility of his special powers and naturally would claim much for them. He may claim too much, especially if men who ought to know better encourage him to do so.

Dr. Moldenke concedes the utility of the test bar of course. In concluding he says, "Sandless pig metal cast in chills is the coming thing in the iron industry, judging iron by its fracture necessarily becoming a thing of the past. Will the foundryman be content to rely on an outsider's word for what is in that iron? Hardly. With half a dozen different brands all looking alike

when broken and no laboratory to tell him, where will Mr. Putnam be at?" With regard to this I have to say that I do not understand that the half dozen brands will all look alike when broken. In fact, I know, from long experience, that they will not look alike. I have graded hundreds of tons of sandless pig metal, cast in chills, with far greater accuracy than I could possibly have done had it been cast in sand. I have advocated the sand-free pig in these columns for a long time past, and have pointed out the fact that fracture of a pig cast in a chill would indicate its grade with great precision. These facts will perhaps assist Dr. Moldenke in arriving at a conclusion as to where "Mr. Putnam will be at" when the sand-free pig arrives.